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THE TELEPHONE QUESTION.

THE *Times* correspondence on the telephone continues. Since we last wrote it has been contributed to by Prof. Kennedy, Mr. Begg, Mr. Wallace, and the Duke of Marlborough. Prof. Kennedy, in a thoughtful letter, calls attention to the extent to which London streets are already "full inside," and hopes that the Duke of Marlborough's frequent references to Mr. Bennett's British Association paper are to be taken only in a very general sense, and not as indicating that the new company is already committed to the more than doubtful plan of parcelling out London into hard-and-fast square mile districts, or to the idea that the Law-Mann-Bennett system is beyond all question the one best adapted to their wants under conditions so different from those under which it has hitherto been used. Prof. Kennedy remarks that possibly it may be, but that it certainly requires proof of an entirely different kind to that given as yet.

Mr. Begg, declining further argument on Mr. Swinton's figures, which he claims to have shown to be inaccurate, enters with some detail into the subject of Mr. Bennett's estimates, and alludes to the absence of what he considers the important item of depreciation. He says, further, that if the new company goes to Parliament for street powers it will find the application costly, and any company running the risk of defeat will justly require a corresponding recompense if successful. In conclusion, Mr. Begg says he does not defend a £20 tariff as a permanency in London, and that he holds no brief for the National Company.

Mr. Wallace, as a director of the new company, answers some of the points raised by Prof. Kennedy, and says that no system will be adopted until it has secured the approval of a commission of technical experts, but he makes no reference to the practical questions raised by Prof. Kennedy on underground working.

The Duke of Marlborough adds, for the information of the public and Mr. Begg, a few further remarks on the plan that the new company will adopt. His Grace says, truly, that there are three courses open—entirely overhead lines, entirely underground, or a mixture of both. The new company contemplate the last-mentioned—overhead for the local exchange lines, and underground for the trunk lines connecting them. The Duke says that it is not very difficult to calculate out the cost of this system, and takes as a basis 50 sub-stations of 500 subscribers each and 50 twins from each sub- to each central-station. He sees no difficulty in either estimating the cost or in laying the wires underground, while as to plant and staff, there never was an industry that required so small an amount of costly plant or so little labour to maintain itself. With a map of London on which are located the various stations and lines, any practical engineer can tell to a nicety what the telephone will cost per subscriber. With a £10, or, at the outside, £12 a year rate, the business should pay 12 to 15 per cent. interest to the shareholders. The Duke thinks the telephone problem is child's play as compared with the electric lighting problem, and the many details incidental to the service he maintains can be settled clearly beforehand, expressing his confidence that any electrician would go gaily into telephoning London with our present knowledge, where he would hesitate many times before giving an electric lighting opinion.

Now it is just the question of "going gaily into telephoning London," which has induced us to point out that it is a problem requiring grave consideration. London wants a good telephone service, and London ought to have it. In addition, Londoners ought to be thankful to any, who, directly or indirectly, help them to get it. But London does not want confusion worse confounded. Such follows the going gaily into an enterprise which ought not to be gaily gone into. No enterprise can succeed in which the difficulties to be encountered are disregarded, or the expense to be incurred under-estimated. We do not say that this is so in the present instance, but we are quite sure that the matter is one requiring the very closest scrutiny and the most cool and careful calculation. It cannot be settled, nor can public confidence be obtained, by a flippant smoothing over of difficulties, or a careless statement of estimates. For trunk lines the Duke of Marlborough allows 10 per cent. The author of the system—which Mr. Wallace stated to be only

under consideration, but to which the Duke of Marlborough adheres in his letter—allowed 25 per cent., though he remarked that it was a liberal estimate. Probably nothing short of experience could show whether the liberal estimate is liberal enough, but unless 25 per cent. is much too much, 10 per cent. must be much too little. Professor Kennedy's reference to the glutted condition of subterranean London was practical and deserved more consideration than it received in the letters which were supposed to answer his. We have stated that the problem of telephoning a great city is a serious one. The Duke of Marlborough thinks it is child's play compared with electric lighting. Now, it is not necessary for us to minimise the difficulties of electric lighting. We know what they are, and we also know that the problems they present are in able hands. But the difficulties which the two problems present have nothing in common. The Duke of Marlborough makes the not uncommon mistake of comparing difficulties which he is aware of with those he does not know. An electrician who would exercise the care the Duke of Marlborough says he would on an electric light subject, would, we are confident, exercise a similar reserve on a telephone question until he had mastered its details.

It is a great pity that the scheme foreshadowed should have been put forth in an immature and, we fear we must add, ill-considered state. While this is to be regretted, it must be credited with a revival of interest from which it is to be hoped good will result. The more the difficulties are faced, and the greater the care with which the details are prepared, the nearer will the promoters be to a success in their enterprise. No engineering problem is too difficult to be solved by the aid of capital, skill, and care, and if it is allied to a commercial problem, it needs only the addition of sound judgment to aid its solution.

THE ELECTRIC LIGHT ON LIGHTHOUSES AND LIGHTSHIPS.

IN a recent issue of one of our French contemporaries there is a complaint concerning the insufficiency of the electric light when used on lighthouses and lightships during certain atmospheric conditions, such as foggy weather, for instance.

It is stated that when it was decided to instal electricity upon the lighthouses of La Hève, where there are two, one of them was fitted up with the necessary apparatus, whilst the other continued to burn oil for a time. This arrangement afforded an opportunity for comparison between the work of the two lighthouses. Sailors generally, and espepecially the pilots of Havre, soon observed, it is said, that during foggy weather there was a great deal of difference between the efficiency of the two sources of light. The brilliancy of the electric light was much more seriously affected than that from the oil lamps, and at times, in very thick weather, it was impossible to make out the former when the latter was still sufficiently visible, so that at the very moment when its services were most urgently required the electric light failed.

In connection with this complaint we may notice one nearer home. A short time ago a deputation of ship captains represented at Trinity House that the electric light in some of the lighthouses, especially those near the entrance to the Thames, was often quite invisible under certain atmospheric conditions, whilst at the same time lightships and lighthouses burning oil could be distinctly made out, and even the gas lamps from towns on the neighbouring coast could be seen.

Further, it has been complained that the electric light from powerful lighthouses of the first class, such, for instance, as that on the South Foreland, presents some very confusing inconveniences, which are not observed in the case of oil lamps. Thus, it is stated that navigators are unable to see around them owing to the dazzling brilliancy of the electric light, and that the powerful bundles of rays cast such deceiving images upon the surface of the waves that sailors become quite confused, and are often unable to appreciate their situation on very dark nights.

These charges are of a most serious nature, whether true or unfounded; meanwhile the adaptation of electricity is extending to second and third class lighthouses. Something should be done at once to investigate the truth of these charges, and, if there is anything in them, steps should be taken at once to so modify the reflectors and other accessories that these alleged disadvantages, if they exist, should be eliminated. No doubt Dr. Hopkinson, if he cared to do so, could state definitely the real position of affairs.

Universal Time.

THE agitation which is continually kept up on the question of universal time seems to be gradually bearing fruit, and it seems not improbable that ere very long something will be agreed upon. There is a very general consensus of opinion amongst the learned societies on the subject, and as soon as an agreement can be come to as to the selection of the hour meridians and the adoption of the hour-zone system, the change will be practically accomplished. The introduction also of the 24-hour notation is an alteration which it seems probable must sooner or later be agreed to, though we cannot but regard the statement that serious consequences, involving loss of money and even loss of life, *might* result from the present 12 notation, as the height of absurdity. At the same time, in cases where the 24 notation has been adopted, it is stated to be highly successful.

Electric Traction Adopted in the Midlands.

WE gladly avail ourselves of the opportunity to congratulate the South Staffordshire Tramways Company on its decision to adopt electric power on a part of the tramway system. At the same time it must not be forgotten that circumstances have gradually forced the directors to adopt electricity as a motive power. Steam has been the power hitherto used, but latterly the residents, backed up by the Board of Trade, have been loud in their objections against this method, and finally the tramway company were informed that steam power must be abandoned by a certain date. As it would be impossible to work the lines with horse-power, the directors have made a virtue of necessity, and prevailed upon the shareholders to adopt electricity, and, at the same time, give them power to raise the necessary money. We gather from the remarks of the Chairman made at the recent meeting that

as the authorities have granted permission, the overhead system will be used. In this they are fortunate, for there are few local bodies in England which would permit the employment of this system, although it might with advantage be adopted in many cases. But on several grounds there is a deep aversion to overhead wires; perhaps to a certain extent it is reasonable, but we are afraid a good deal of this antipathy has but scant foundation. However, the success of the Staffordshine line may do a great deal to eradicate false notions, and electric traction in England, which has lagged to an inordinate extent, may receive a fresh impetus, and advance almost as rapidly as it has done with our American cousins. The chairman says that it is expected that the new scheme will save the company 3d. per mile, on the present working; however natural it is to indulge in these statements we fear it is not wise, because no matter how carefully comparisons are made, there is always a certain possibility of error, and if the working results do not exactly coincide with the estimates, there are those who are only too ready to seize upon the exaggerated statements and belabour both electric traction and its advocates.

Florence and Fiesole Electric Railway.

THE paper which we publish this week by Mr. Sheibner, on the Florence and Fiesole Electric Railway, is full of interest to electricians and general engineers. It is a work which has been successfully carried out under most singular and trying difficulties. It was unfortunate for the company owning the line that an accident should occur soon after the opening, by which five persons lost their lives, for it resulted in the Government stopping the working until an enquiry had been held. We are glad to note that this enquiry has conclusively shown that the accident was in no way due to the failure of any part of the system, but entirely owing to the negligence of a brakesman. The line was reopened in April of this year, and has continued to work with regularity and perfect safety. The working expenses given in the paper do not convey an absolutely correct idea of the state of the railway at present, as the figures were taken at a very early stage of the operations. No doubt we shall be able to present at the end of the year a more detailed statement, which will give a more accurate notion of the working of the line.

International Congress of Electricians.

To those who have watched the proceedings of the International Electrical Congress must come the conclusion that the gathering just terminated has probably been the largest and most representative of the world's electrical science which has ever met. From first to last it was a distinct success, and while these annual meetings of electricians are marked with so much fervour and energy, it may be safe to aver that the Congress has a long and reputable life before it. Germany, strong in its patriotism, was represented by an overwhelming force of electricians, while other countries were represented by men well fitted by experience and knowledge to take part in so august an assemblage. Our correspondent, in his interesting communications, draws attention to the high pressure which has characterised the whole proceedings. Beginning at an early hour, so early, indeed, as would have filled with alarm the devotees of English scientific gatherings, it continued its ceaseless labours until the day was far advanced. Whatever may be the outcome of the papers, there has been no dearth of suggestions. We may in a future issue attempt to criticise some of the opinions promulgated at the Congress, but for the present we only express our wonder and admiration at the quantity of work which has been done. Of course, the success of the gathering may, in a great measure, be due to the combination of attractions, for, as we have pointed out, the Lauffen transmission scheme has been responsible for collecting together prominent scientists from all parts of the world. It is with pleasure that we notice the English electricians, both in original papers and in the discussions, fully upheld the renown of English science.

The Brush Company's Dividend.

WE are glad to be able to welcome the Brush Company to a dividend-paying stage. It is, however, impossible, on account of the peculiar nature of the items, to offer any comment on the report. The company has hitherto had a very varied and chequered existence, and it seems now as if it had safely passed the shoals which threaten disaster to joint-stock enterprise, and henceforth we shall hope for results satisfying both to shareholders and to customers.

Elmore Copper.

WE have received from Elmore's Patent Copper-Depositing Company a copy of a compilation of testimonials to the value of the company's goods. It is well designed and printed, the title being in bronze ink, and the copies of testimonials show the perfection of recent developments in the art of fac simile printing; but, it gives a very poor impression of the extent of the company's business, and does not indicate that the predicted "Revolution in the Copper Industries" is much nearer fulfilment. In sending us the testimonials, the Secretary says:—"You will see that the opinions therein expressed are very emphatic in their appreciation of the excellence of the productions made by the Elmore process and of their superior adaptability for commercial purposes as compared with ordinary goods." But we don't see it. What we do see is fourteen testimonials from those who find the productions answer their purpose, some as well as, some better than, similar goods produced by other means. Five of the testimonials are from makers of paper-making machinery, one each for tubes used by mineral water machine makers, for calico printing, hydraulic cylinders, one for coating hydraulic ram, and five for purposes not stated. The thousand and one purposes for which Elmore copper was to be substituted for that in general use are conspicuous by their absence. No instances whatever are given of the use of steam pipes, and the only reference to tubes for standing pressure is the letter of earliest date, in which the writers say they have not tested the 12-inch tubes for pressure, but they like the look of them, and will write again. A fac simile letter from Mr. Wm. Elmore, included in the compilation, states that the letters are from firms whose names are foremost in the trade. From the trades represented, perhaps, they are—we are not sufficiently acquainted with those trades to judge—but they are certainly not foremost in the copper trade generally, and not of any world-wide celebrity. That the publication of these testimonials will tend in any way to establish a large demand for the company's goods may be doubted, whilst the fact that it gives indication of an existing demand from a very limited area, and of a very small extent, is undoubted. But, as we remarked, the book is well-designed and printed, and has an imposing exterior. Perhaps this may have been relied upon to exercise some influence upon others than users of copper goods.

ELECTRIC RAILWAYS FOR RAPID INTER-URBAN COMMUNICATION.

By CARL ZIPERNOWSKY.*

(*Continued from page* 326.)

Construction of the Carriages.

A CARRIAGE contains, besides 40 seats for passengers, two w.c's., and, opposite to the latter, spaces for the post and for the conductor's appliances.

The carriage is 45 metres long, 2,150 mm. broad, and 2,200 mm. high. At each end is a paraboloid surface, so that the resistance of the air, which at the high velocity intended absorbs the greatest part of the driving power, may be reduced as far as possible.

The two end compartments of the carriage are exclusively set apart for machinery, and are inaccessible to the public. They are shut off from the intermediate part of the carriage by sheet iron walls, with glass doors and windows. A similar screen is necessary for the driver's position, as very considerable currents of air will be felt within the machinery compartment. The two machinery spaces represent each a truck.

The framework of the carriage is a system of longitudinal supports, which pass along the two machinery compartments to the four corners, and are formed between the two trucks into a kind of framework, which carries ribs for strengthening, at intervals of 1,500 mm. each, secured together by bands and cross-pieces. This construction is necessary for the central portion of the carriage, which receives the passengers, because, on the one hand, the sides have to be perforated above the supports for the introduction of the windows, and, on the other hand, because the prolonged free middle part must be constructed capable of sufficient resistance against collapse.

The box of the carriage rests upon two rotary frames, and is supported by the latter by means of 16 pairs of "evolut" springs, enclosed and fixed in cast steel boxes, which slide within each other telescopically.

These boxes are firmly connected with the framework of the carriage, and can slide in a circuit within the shoes screwed upon the frame of the rotatory supports. Each truck can be turned towards the longitudinal axis of the carriage in a curve which in the case before us corresponds to a curve of 1,000 metres radius. The lateral movement of the body of the carriage within the truck is here 6 mm.

The turning frames consist of two sheet-metal bearers which are expanded upwards above the axle boxes, so as to gain the space necessary for the latter. The sheet-metal bearers are connected with each other to a single frame by means of four cast steel traverses. The frame inclines at each end against two suitably arranged uprights of the carriage body, and by their means, whilst remaining completely movable, both horizontally and vertically, transmits the impulse of propulsion to the body of the carriage.

On each axle of the truck there is mounted directly an electromotor, the magnetic system of which is firmly connected with the frame of the truck. A carriage, therefore, has four electromotors. Such a perfectly rigid connection of the electromotors with the framework and axles is, of course, admissible only when both the changes of incline are carried out on a sufficiently great radius, and when in the transit curves the outer rail is made to exceed the inner rail in height very gradually, thus preserving the truck from running on a warped plane. Further details will be given below on the conditions which we have established for this purpose.

The driving wheels are made as large as possible, and provided with two flanges. The outer flange is merely a precaution against "derailment," and it is at the distance of 5 millimetres from the head of the rail.

The internal flanges have also a play-room of 5 mm., because the heating and consequent expansion of the axles must be taken into consideration. From this arrangement it follows that before the inner flange begins to rise upwards from any cause the outer flange of the second wheel runs on the head of the rail, and thus joins in the guidance of the pair of wheels.

Wheels with double complete discs have been used, the grooves of which turned in the flange catch in corresponding notches in the tyres. The tyres can therefore be very easily exchanged, but they must be very carefully constructed, on account of the heavy strain thrown upon them.

The two discs of a wheel are of a conical shape, and they are held together by means of screws which pass through their naves. Hereby the nave is held firmly, and with a uniform pressure along its sides, without occasioning in it unequal tensions; at the same time, the naves are pressed upon the axle.

In order to prevent the wheels from becoming loose, the naves of both discs are shortened in such a manner that in the annular space which remains between them there may be room for two half rings to be laid in a notch of the axle, and an entire ring to be drawn over them. The wheels were further secured by four flat wedges, which are sunk to the depth of 5 mm., both into the naves and the axle.

The tyres are prevented from turning within the wheel discs by a number of screws which hold the two discs and the tyre together.

Particular attention must be given to the bearings. At a wheel pressure of nearly 7,500 kilos., and a rotation of about 600, which is to be expected, it seems indispensable to have a quite peculiar lubrication totally different from the ordinary construction. The oil cups must be closed, in spite of the disadvantages involved, and yet the axles must run in oil.

Our construction consists essentially of a disc screwed on at its blunt end and hollowed out at its circumference to an annular channel. It is sub-divided into compartments by cross partitions, from which oblique perforations permit of the escape of the oil. The cross partitions serve, on the one hand, to fill the divisions of the channel, or to effect a lifting of the oil which is spurted up in the oblique perforations by centrifugal force. On the other hand, it serves to force up the oil collected from the lower part into the hollow space of the upper part, where it is collected in a trough-shaped compartment, and is conveyed into the oil cup through numerous apertures. By means of this arrangement the axle can certainly be made to run continually in oil. But it is necessary to ascertain by experiment whether this arrangement is equal to the extraordinary demand, concerning which we will merely remark that for a pressure which may reach 12 kilos. per square millimetre, the work of friction in the axle bearings may reach 4 micro-kilos. per square millimetre.

Exactly in the middle of each truck there are two contact wheels for taking up the current, which run on the current rails. The placing of these wheels, with their axles, exactly in the central plane of the turning frame, is a necessity, since during the journey they must roll as far as possible exactly over the rails which convey the current. This is effected by allowing them to make only very small axial movements within their bearings, and it is consequently possible to make their flanges to embrace the head of the current rail on both sides, and thus to obtain the largest possible transition surface for the current.

As it appears from what follows, the problem is to convey very considerable quantities of current from the current rails into the wheels, and from here into the conducting cable of the carriages. Hence great attention must be paid to the contact arrangements.

The contact wheels must have a great diameter, in order that they may not run with too high a number of rotations, and that the arrangement of their bearings may present no difficulties. They must be very light, in order to accommodate themselves easily to all motive impulses which are communicated to them on their way; but at the same time they must run with a certain pressure upon the rail, so as to secure a certain contact. We have constructed them in the same manner as the running wheels; that is to say, of two discs of sheet steel.

The three bearings of each pair of wheels are held by three rotatory arms, connected with the frame of the truck, and they are pressed against the current rails by three spiral springs acting vertically. The current is taken up from the contact wheels by means of massive copper blocks, which move along sliding rings.

* Read before the International Electrical Congress held at Frankfort-on-the-Main, September 8th, 1891.

The axle of each pair of wheels is bipartite, and the insulation is so arranged that neither the axles nor their bearings convey current.

The contact wheels and electromotors are accessible from a narrow bridge, which runs through the entire machine room at half the height of the body of the carriage.

The brakes deserve a very high appreciation, since it is a main condition of safety in a carriage moving at the rate of 200 to 250 kilometres hourly to annul the *vis vivâ* of the same, equivalent to 60 tons, in the shortest time possible, and to succeed in stopping the vehicle.

The resistance of the atmosphere acts, indeed, to a certain extent as a brake, which is, in fact, very considerable, as we shall see below, and represents about 200 H.P.

In travelling on a horizontal line all other resistances are very trifling as compared with the resistance of the air. It is hence evident that if the 200 H.P. which maintain the state of motion suddenly cease to act, the carriage in the first moment is held back with a force equal to this 200 H.P., and that hence a first brake action is occasioned by simply shutting off the current. This, however, is of avail only for the first moment, since with the decrease of the speed the action of atmospheric resistance declines.

A successive and very efficient brake action is obtained if we connect the electromotors after they have been turned off, with an external resistance, applied, *e.g.*, underneath the carriage, and allow it to act upon this resistance as a primary machine. It is indifferent whether we use continuous or alternating current machines. The arrangement of transfer apparatus for this purpose involves no difficulties, and we shall merely have to arrange that as the speed decreases we are able, on a great decrease of speed, so to re-arrange the machines (which were at first introduced in parallel) that at first every two machines act upon the resistance in series, and on a further decline of speed, say to about ¼, all the four machines may be connected in series.

The brake action thus attained is more permanent, but it is not sufficient, since hereby the speed cannot be reduced below 30 kilometres with sufficient rapidity.

Hence a mechanical brake must further be applied, which may reinforce the above-mentioned brake action. For this purpose we consider that system of brakes most suitable which acts most certainly and rapidly, and to this end we fit up the carriage with two air reservoirs and eight cylinders. The dimensions, the contents and the pressure, have been calculated as sufficient, and the loss of pressure after every pressure may be supplied by means of an air pump, worked either by hand or by means of a special small electromotor.

The two reservoirs are constructed of 4-inch pipes, and are each 30 metres long. The carriage is also provided with "air puffers" adapted to utilise the heat arising from their action for the production of watery vapour which is then allowed to escape.

For this purpose the bottom of the puffer is lined with a plate of felt, which is always kept moist, and draws up water from a tray at the bottom of the puffer. This puffer merely serves to prevent two carriages in the running shed from coming too close to each other, and it is therefore adapted for a movement of the speed of 1 metre which, on a track of 500 mm., is annulled in such a manner that the greatest part of the shock is converted into heat, and the structure of the carriage is not injured.

The carriage was further equipped with coupling chains which, in case of need, serve to draw any carriage which is not locomotive. At each side of its front there is a powerful reflector lamp, which throws a sufficient light upon the track, and can be turned in any direction. The illumination of the line must be such that any obstacle—a fallen tree, or the like—can be observed in sufficient time to stop the carriage, hence the reflectors, even in dull weather, must be able to throw their light to the necessary distance.

Not to interfere with the survey of the more important parts of the carriage, we have not included in our description the further arrangements, but we must mention the following points:—

The lighting is effected by means of glow lamps, fed by the working current, for which purpose a special apparatus is introduced to compensate the influence of the varying tension. The warming is effected, for the sake of simplicity, with two Briquet furnaces placed in the space between the two walls. The windows do not open, and are fitted with double panes of glass. The ventilation is introduced in the lantern top of the carriage.

Principles for the Installation of the Line.

In the foregoing section we have sought to explain clearly the manner and the means of intercourse upon which the execution of the project is founded. We will now determine the essential characters for the installation of the line.

As it was already mentioned in the introduction, the gradients present fewer obstacles to a speed of 200 kilometres and upwards than do the curves. In order to overcome ascents at great rapidity we need merely power, and we can always assume that there will be no deficiency of power at the right place. But the speed of travelling is limited by curves, whence it must be fixed *à priori* that only gentle curves, as large as posssible, are to be used. For the open tracks which are to be traversed at full speed we have decided on curves with a minimum radius of 3,000 metres. Where this is impracticable on account of the features of the ground, the speed must be reduced. The lateral pressure must be completely annulled whilst traversing the curves, therefore an elevation of the outer rail is necessary.

This signifies that the elevation is to be effected by raising the outer and lowering the inner rail. The extra height for a speed of 200 kilometres and for curves with a radius of 3,000 metres is 148 mm., at which the resultant of centrifugal power and specific gravity arrives at a normal position. The greater the extra elevation the more difficult becomes the transit from straight lines to a curve. Not more than a super-elevation of 180 mm. can be reached without imperilling the safety of the transit into the curves.

The more abrupt the curves the more must the speed of travelling be reduced. But, as this entails loss of time, it is self-evident that the minimum curves must have a radius of not less than 1,000 metres.

In drawing the plan, the speeds possible in the curves must be taken into account, and for every curve the degree of super-elevation must be determined singly, on the basis of local circumstances, inclines, the direction of the traffic, &c.

The particular attention which must be given in tracing the curves renders it more difficult to overcome the configuration of the ground, and in order, nevertheless, to have the necessary free space, it is necessary to be less anxious about the gradients. We have, without hesitation, used gradients of 10 per 1,000 on the Vienna-Budapest project, and we assume that the ascent can be effected at the speed of 200 kilometres. The power required is however twice as great as that for a horizontal line at the same speed.

Sharper gradients than 10 in 1,000 would have an unfavourable effect upon the total traffic, on account of the critical weight of the electro-motors which must be proportionally stronger, and they are therefore to be dispensed with if possible. When unavoidable, they must be traversed at a reduced speed.

From the aforesaid it appears that the average speed in hilly and mountainous regions will not be more than 200 kilometres per hour, whilst in straight declivities the losses of time which occur in steep ascents and sharp curves can be made good at a maximum speed of 250 kilometres.

After we have thus explained the general principles of tracing out the line, we turn to the construction of the superstructure, which is in close connection both with these principles and with the structure of the carriages.

Against derailment we are secured, above all things, by the great diameter of the driving wheels, and by the construction of the carriage, whose two turning frames can obtain a better guidance within the track (a play-room of only 5 mm.), than is possible with fixed axles. Their considerable length is the best means to prevent a serpentine movement of the carriage, and thus exclude the chief cause of derailment. A second safeguard against derailment is afforded by means of the second flange, and thereby that we make all the flanges 50 mm. high, so that each wheel obtains guidance for 950 mm. of its circumference. Lastly, in case a derailment should still occur, we have adopted a safety arrangement in the carriage, by causing the four double consols which connect the supports of the grating with the machinery to extend so deeply, that on the fall of the carriage wheels from the running rails, they extend over the two outer sides of the

rails, and thus afford the carriage further guidance. Moreover, the entire carriage is fixed so low, that the descent to the current rails is only 100 mm., and must therefore, after derailment, slide on the current rails, which would still afford a level track, if even the insulators should break.

(To be continued.)

TRANSFORMER LOSSES.

By JOHN H. RIDER.

In the discussion which followed the reading of Mr. Swinburne's paper on "Transformer Distribution," before the Institution of Electrical Engineers in February of this year, several speakers of high standing expressed the opinion that the iron losses in a transformer practically vanished at full load. In fact, Mr. Mordey cited some experiments he had made which bore out this statement. As the truth or error of this must have a great influence on the efficiency of transformers, it was determined to make a practical test of the matter, on the same lines as suggested by Mr. Mordey.

Through the kindness of Messrs. Blakey, Emmott & Co., Limited, of Halifax, the experiments were carried out at their works and with their apparatus.

An experimental transformer was made up in the following manner. The iron circuit consisted of rings 8¼ inches outside diameter, × 5½ inches inside diameter, × 0·03 inch thick; and of rectangular plates 8¼ inches long × 2¾ inches wide × 0·03 inch thick. These were built up alternately as in fig. 1, and the coils, P and S, filled the space as shown.

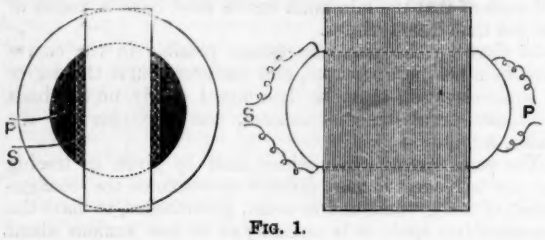


FIG. 1.

95 rings and 95 plates were used, each plate being insulated with enamel paint on one side. The total length of combined rings and plates was $5\frac{1}{16}$ inches, and the total weight of the iron was 41 lbs.

The secondary coil consisted of 64 turns of 116 mils D.C.C. copper wire. Upon this was wound the primary coil, consisting of 640 turns of 40 mils D.S.C. copper wire, the total weight of copper being 10 lbs.

This transformer was then placed in a wooden box, measuring 14 inches deep × 16 inches long × 11½ inches wide, and the box was filled to the top with a heavy mineral oil. Means were provided for keeping up a constant circulation of the oil during the experiments. A thermometer was immersed in the oil with its bulb about half way from the top of the box, and between one of the long sides of the transformer and the side of the box.

A number of preliminary tests were taken, and as it appeared that the temperature of the oil was still slowly rising after a number of hours, to avoid any error due to this, the oil was always heated by external means to a temperature far higher than it afterwards attained, and all readings were taken with a descending instead of an ascending temperature.

The primary coil of the transformer was first connected to a "Blakey-Emmott" alternator running at a constant speed, and giving 1,000 volts at a periodicity of 100 per second. The secondary coil was simply joined to a voltmeter, and its indications were kept at 100 volts throughout. The maximum constant temperature recorded in this test was 160° F. and the temperature of the air was 78° F.

A continuous current was next applied to the primary coil and adjusted to such a strength that the maximum constant temperature reached was 160° F., as before. This current measured 4·7 ampères.

The primary coil was then reconnected to the alternator, and a current of 16·35 ampères taken from the secondary coil, a water bath being used as the resistance. The volts at the terminals of the secondary were kept constant at 100, as in the first experiment. The maximum constant temperature now reached was 179·8° F., the temperature of the air being still 78° F.

A continuous current was then again applied to the primary coil and adjusted to maintain a constant temperature of 179·8° F. This current measured 5·25 ampères.

The resistances of the primary and secondary coils, were carefully measured after each experiment with the following results:—

At 160° F. primary = 8·95 ohms.
„ 179·8° F. „ = 9·26 „
„ „ secondary = 0·09 ohm.

Taking the continuous current readings first, we have the following results:—

At no load (Temp. 160° F.) current = 4·7 ampères.
Resistance = 8·95 ohms.
$\therefore$ Loss = $4{\cdot}7^2 \times 8{\cdot}95 = 197{\cdot}7$ watts.
At full load (Temp. 179·8° F.) current = 5·25 ampères.
Resistance = 9·26 ohms.
$\therefore$ Loss = $5{\cdot}25^2 \times 9{\cdot}26 = 255{\cdot}2$ watts.

Of these losses we can account for the following as copper losses, viz:—

At no load, magnetising current only in primary.
Mean value = 0·14 ampère.
Primary resistance = 8·95 ohms.
$\therefore$ Loss = $0{\cdot}14^2 \times 8{\cdot}95 = 0{\cdot}1754$ watts.
At full load, primary current = 1·775 ampère.
Primary resistance = 9·26 ohms.
$\therefore$ Loss in primary = $1{\cdot}775^2 \times 9{\cdot}26 = 29{\cdot}17$ watts.
Secondary current = 16·35 ampères.
Secondary resistance = 0·09 ohm.
$\therefore$ Loss in secondary = $16{\cdot}35^2 \times 0{\cdot}09 = 24$ watts.

Summarised, this result appears thus:—

	With direct current.	With alternating current.
At no load. Temperature in both cases at 160° F.		Primary loss = 0·1754 Secondary loss = 0·0 Iron losses = 197·52
	Watts lost = 197·7	Watts lost = 197·7
At full load. Temperature in both cases at 179·8° F.		Primary loss = 29·17 Secondary loss = 24·0 Iron losses = 202·03
	Watts lost = 255·2	Watts lost = 255·2

Or after deducting the copper losses from the observed total losses, we have for the iron losses at full load, an *increase* of 4·51 watts, or a difference of only about 2¼ per cent.

The measuring instruments used were a Siemens dynamometer, a Cardew voltmeter, and an ordinary Wheatstone bridge.

The particular transformer used was only an experimental one made up for the occasion. The iron losses (and consequently temperature) were purposely high, in order that the comparisons might be more pronounced.

The experiments were conducted throughout with great care, the figures being checked by several observers. The results do not seem to be at all surprising, as it is hard to understand what actions could be going on in the iron at full load which would not be present at no load. The periodicity and induction are the same in both cases, and as the hysteresis and Foucault current losses depend solely upon the values of these, it should follow that they will be the same in both cases as well. The iron in the Transformers upon which Mr. Mordey made his experiments must have been indeed "phenomenal."

As Mr. Trotter pertinently remarked (*Journal I.E.E.*, Vol. xx., No. 92, page 240):—"The hysteresis may very probably disappear at high frequencies, and one is quite prepared to assume that it does. But the whole difficulty is, why does it diminish (the frequency being the same) with the increased load?"

ADDITIONAL FACTS CONCERNING THE HISTORY OF THE ELECTRIC TRANSMISSION OF POWER.

BY A. M. TANNER.

Now that the subject of the history of the electric transmission of force is being extensively discussed, it becomes of interest to bring to light and general notice the following additional facts concerning the matter.

In the "Milanges Physiques et Chimiques," of the St. Petersburg Academy of Sciences for the year 1870, vol. viii., Prof. Jacobi says: "In my prior work I repeatedly made the experiment of locating such an electro-magnetic motor in the plane of the magnetic meridian, and obtaining a magneto-electric current by mechanically turning the apparatus. In article V. of my 'Mémoire sur la Théorie des Machines Electro-Magnetiques,' published in the year 1850, I stated that every electro-magnetic machine could also be worked as a magneto-electric machine, and *vice versâ*."

In Poggendorff's "Annalen der Physik" for 1851, vol. lxxxiv., page 187, Dr. Sinsteden, in describing experiments with a magneto-electric machine, says: "These magneto-electric currents thus increased to an enormous strength can also be utilised in force machines (electric motors) in place of the costly hydro-electric currents, over which they would have the important advantage of causing no running expenses by reason of the consumption of zinc and acids."

In the same work, vol. xviii., A.D. 1883, von Waltenhofen states that Prof. Pfaundler, of Innsbruck, experimented with the Kravogl electric motor exhibited at the Paris Exposition of 1867, and found that it could be used for generating continuous electric currents.

Prof. von Waltenhofen bases this statement upon a letter received by him from Prof. Pfaundler, dated November 9th, 1867, which says:—

"I am sorry that I cannot return and see the motor (Kravogl) again; I would have liked very much to make experiments with the same by using it reversibly, and thus producing electric currents and the electric light by mechanical work. It is my intention to apply a strong force for turning the wheel in an opposite direction from the rotation effected by the battery, and then gradually cut the latter out of circuit. This idea of Siemens can surely be also applied to the Kravogl motor?"

In another letter of Prof. Pfaundler, dated February 11th, 1870, it is stated that: "The Siemens principle can, in fact, be applied to the Kravogl motor. When the same is driven by hand (without a battery), a current is produced of the strength given by a Bunsen element."

A French patent of Cazal, dated May 25th, 1864, No. 63,155, describes and illustrates an electric railway system in which one or more magneto-electric machines are operated by hydraulic or wind motors, and the current generated is conveyed to a rotary car motor by wires and the track rails upon which the car runs. In this patent of Cazal we have another instance of the utilisation of natural forces fordriving magneto-electric machines, and the conveyance of the electric currents from these machines to distant electric motors.

In view of the citations in the present article, and the description of Major Bessolo's system in a former article of the writer, it certainly cannot be held that Gramme made a great discovery when he ascertained the reversibility of his special dynamo-electric machines, and used two identical machines, one for the generator and the other as the motor.

ELECTRICITY IN NEW SOUTH WALES.

[FROM A CORRESPONDENT.]

ON August 17, Mr. Cracknell's and Professor Threlfall's report, on the scheme for electrically lighting the city of Sydney, was presented at the city council.

The scheme proposes three central stations, one in Kent Street at Dawes Point, one in Woolloomooloo, and one in Prince Alfred Park next the railway terminus.

The sites on which it is proposed to build the stations have many advantages; they are splendidly situated for supplying, forming almost an equilateral triangle and each in the centre of almost separate districts, and all well situated for the delivery of coal; Kent Street and Woolloomooloo by water from Newcastle, and Prince Alfred Park by rail from the southern collieries.

The scheme proposed embraces both public and private lighting, but these have been kept almost entirely separate in the calculation of cost. The streets which are at present lit by about 4,000 12-C.P. gas lamps, at a total annual cost of £12,238, will be lit by means of a combined system of arc and incandescent lamps. The principal streets and thoroughfares such as George, Pitt, King, and Oxford Streets and Hyde Park, &c., &c., will be lit by means of 431 arc lamps of 2,000 candle-power nominal, on poles 40 feet high and 4 chains apart alternately on opposite sides of the street, giving a virtual distance apart of two chains. These arc lamps will be run in 11 circuits each of about 40 lamps in series.

The mains will be laid underground, and the circuits will be so arranged that lamps on opposite sides of a street will be on different circuits so that in the possible event of a breakdown of one of the circuits, no street will be left in perfect darkness. The circuits average about 5 miles in length, the longest being a little over six miles.

The lesser thoroughfares will be lit by means of 25 candle-power incandescent lamps, run in multiple series of 40 lamps in each circuit, overhead construction being used as much as possible. A few gas lamps have been left, and about 20 incandescent lamps would be supplied from the low tension private lighting supply at Kent Street. It is proposed that half the arc lamps be extinguished at 12 o'clock, the remainder being worked all night.

The total cost of the installation for street lighting, including a system of trunk mains to connect all stations together in case of fire or any other accident, is estimated at £106,260 and the total annual cost of maintenance at £15,833 or a little over £24 per annum per arc lamp, and £3 12s. per annum per incandescent lamp.

It is proposed to begin the private lighting with a provision for plant equivalent to the continuous supply of 10,000 60 watt lamps, allowing from 14,000 to 16,000 lamps wired; the cost of this is estimated at £60,770, and it is proposed to charge 8d. per B.T.U. The private lighting will of course be divided amongst the three stations, consumers in the immediate vicinity of the Kent Street station being supplied by means of the direct low tension system, and those beyond this area being supplied by means of high tension alternating currents and transformers. The district round the Kent Street station, comprises most of the principal hotels, warehouses, shops, &c. The Kent Street station is expected to absorb half the private lighting, Redfern two-fifths, and Woolloomooloo three-fifths.

PRACTICAL PHOTOMETRIC RESEARCH.

BY RALPH CONRAD RICHARDS.

CONCERNING PLANT LIFE.

(*Continued from page* 332.)

AMONG the many fields in which electricity plays a prominent part, that of lighting is one well deserving of consideration; the developments in this direction have received adequate attention at the hands of numerous writers, and for this reason few have turned about in search for new applications of the arc or incandescent lamp.

There is, however, one direction in which comparatively little has been accomplished; the writer refers to the improvement of plant life. The explanation of this fact, which must be regarded as extraordinary, is due to two reasons; in the first place because few have realised the enormous scope open to engineers in this respect, and secondly, owing to the very great ignorance (which still exists in many quarters) of the requirement of successful plant cultivation.

There are many experiments on record, in which it has been attempted to accelerate the growth of plants by allowing the rays from an arc lamp to fall upon them. For the most part these have proved signal failures, until the introduction of suitable modifications; it is therefore time that something be done in order to dispel that ignorance which must always be the premonitor to the accomplishment of any enterprise at its first inception; this, then, will be, to a certain extent, the object of the present article, and if the writer should be

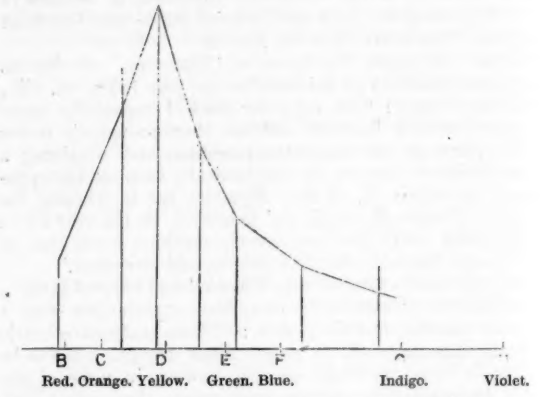
the means of directing the attention of future investigators into the right path he will be amply repaid the little labour expended upon it.

It is generally conceded that a certain amount of illumination is necessary for the development of vegetable life in a vigorous manner; this is the case, whether the tropical or any other species of plant life be included under the term. It is true, certainly, that certain fungi progress better without illumination, but then it must be remembered that these cryptogamous growths partake far more of the animal than of the vegetable nature. To cite two differences in this respect, the food of the fungi is of an organic nature, and it is believed that they exist by inhaling oxygen, and not, as in the case of true vegetables by decomposing CO_2, retaining the carbon, and exhaling the gas just mentioned. Thus it happens that the growth of fungi in the vicinity of domestic inhabitations is not conducive to health. It is unnecessary to do more than touch upon these few important distinctions, in order to show their lack of conformity to the general laws of vegetable life.

There is a peculiar substance contained in the cells of plants, which the chemist terms chlorophyl. This is the colouring matter which endows vegetable life with its characteristic green colour. This substance is a very good indicator of the health of the species, inasmuch as it is present in quantities which bear a certain ratio to the health of the plant. The production of this green matter is due to the absorption of carbon from the CO_2 contained in the atmosphere. Thus, it will be readily seen that, as the structure of a plant is largely composed of carbon (which it can only attain through the action of light-rays) how all-important is the relation of this physical agent in plant culture. Heat also enters into certain relations with the assimilating processes, but as long as this does not exceed certain wide limits little harm can result.

If a plant be taken into a place destitute of illumination, and suffered to remain there for a lengthened period, it will gradually lose its green colour, and become altered to a sickly yellow, which is due to the decomposition of the grains of chlorophyl in its cells. There is a species of white lilac, to be met with occasionally; this is produced in underground cellars in certain parts of France, the whiteness being due to the same cause. All that has been written here would seem to imply that, as CO_2 constitutes the food of the plant, it is therefore impossible for too great a percentage to be present in the atmosphere. This is not the case, for it has been found that if this gas be present in a greater amount than one-twelfth of the total composition of the atmosphere it acts in the most deleterious manner. This fact does not account for the vitiated condition of plants confined under glass, for experience shows that this is due not to an excess but to a deficiency of this substance, *ceteris paribus*. From this circumstance the desirability of keeping animals in the neighbourhood of plants becomes at once apparent. It is not, however, with the chemical theory of plant life that the experimentalist need concern himself so much as the all-important question of illumination. One of the most successful experiments in this direction was due to Sachs, who adopted the device of placing certain plants in a glass vessel fitted with a narrow tube at its upper part; the termination of this was closed, whilst the lower extremity of the larger vessel was open. The whole vessel was then filled with water and inverted over a pneumatic trough; slips of certain plants —*Uratophyllum, Myriophyllum, Udora (Elodea), Potamogetor*, &c.—were introduced, and the rays allowed to fall upon them; the number of bubbles set free in a given time being considered a measure of the activity of the illumination. For the purpose of determining the relative activity of the two halves of the spectrum, two cells were prepared, one containing an ammoniated solution of oxide of copper, the other a solution of bichromate of potassium. The first cuts out the red half and the second the violet portion, both cutting out all the rays up to the centre of the green; each solution, therefore, admitted but one-half of the spectrum to the vessel containing the slips of plant. It was found from these experiments that the red half has vastly greater power than the violet, so that the absurdity of calling the violet half the chemical rays, because they happen to decompose certain sensitive preparations of silver, is at once established; further experiments by the same physicist demonstrate the accuracy of Draper's curve of intensity shown in fig.

From this curve the relative intensity of the various rays of the solar spectrum is shown, and it will be noticed how great is the resemblance to the curve of luminosity, due to the writer in the second article of this series (ELECTRICAL REVIEW, March 27th). It will be seen, too, that the effect of any ray is due simply to its wave length, and not to its mere *colour*: this being, for convenience, imagined as separate



DRAPERS CURVE SHOWING THE INTENSITY OF VARIOUS PARTS OF THE SPECTRUM "ASSIMILATING RAYS."

from the period of vibration. The effect of keeping plants confined in a room illuminated with light of various colours is shown in the table below, and the great disparity from the effect of rays partaking of these colours upon a sensitive silver plate will be observed. It must, of course,

TABLE V.

Colour.	Between lines.	Effect.
Indigo violet	G—H	1
Blue green	F—G	2
Green	E—F	3
Greenish yellow	b—D	4
Yellow	c—E	7
Orange yellow	B—D	10
Orange	a—C	6
Red	A—a	3

be borne in mind that an excess of brilliancy will, in any case, be harmful; the turning point, or what may be called the point of reversion, being an amount of illumination equal to the brilliancy of the sun in the temperate zone at 12 o'clock. To get a correct idea of this, in the absence of reliable data, it may be said that a room lighted moderately by artificial agents, according to the author's table, will be illuminated about 10 times more efficiently by the sun's rays at 12 o'clock. Now this reversing point is a very important factor in the artificial culture of plants. Experiments were recently made, wherein a powerful arc was employed, the effect being disastrous to the plants, and only ceasing to be so when the lamp was removed to the exterior of the house. This was just what might have been reasonably expected, when it is remembered that the rays from an arc of about 2,000 C.P. are about four times the intensity of the sun's rays at 12 o'clock during the summer months; the arc being about 10 feet above the ground. It is safe to say that a globe of suitable opacity would have accomplished the same result as removing the lamp from the house. One very striking experiment shows in a clear manner the *instinct* of heliotropic plants. If one of these be placed between two light sources, one more powerful than the other, it will gradually be turned towards the stronger, and this turning may be measured by suitable means. If, however, one light source lie beyond the reversing point, the plant will turn in the direction of the weaker. This seems to demonstrate the hurtful influence a light may exercise when too powerful. If one would not attempt to cultivate the lily of the valley beneath the glare of a tropical sun, it should surely be regarded as ridiculous to instal a powerful arc lamp in the vicinity of plants only suited to the ordinary conditions of natural culture.

It has been found that the vegeto-actinic rays range between $\frac{69}{100000}$ and $\frac{40}{100000}$ in wave length; the medium

being $\frac{59}{100000}$,* which gives the maximum effect; beyond these limits no evolution of oxygen occurs, hence the absurdity of glazing houses with blue glass is manifest. For the best utilisation of all the rays for artificial culture, it would seem well to have the light suspended in the centre of a circular house, and a large reflector arrangement placed above to reflect all the rays of upward emission downwards; a lower and small reflector reflects all the downwardly *emitted* rays upwards,† thereby distributing and softening the light. Care should be taken that neither too much nor too little CO_2 be admitted to the atmosphere; a suitable CO_2 generator could be arranged to give the best results, whilst the amount present could be gauged by the absorption by an open vessel of determinate size, of potash in a given time. The temperature should be maintained at about 30° C. for good *natural* development, any excess of this being calculated to cause abnormal growth; 50° C. is, as a rule, sufficient to kill most plants in about 10 minutes, whilst in water a less temperature suffices.

These remarks have, of course, no reference to the cultivation of fruits or plants of exotic origin, such being able to withstand the temperature and brilliance of a tropical sun, which is equal to about one and a-half or twice the values already given. There are also many plants which thrive better with less illumination, these are for the greater part of forest origin.

(To be continued.)

* There is a peculiar exception to this rule in the case of vetch seedlings, which are affected strongly at the extremities of the spectrum and but little at the centre, towards which they are affected but slightly.

† A similar apparatus is illustrated in the author's article for January 30th.

THE INTERNATIONAL CONGRESS AT FRANKFORT.

[FROM A SPECIAL CORRESPONDENT.]

II.

SOMEONE has named this congregation of electricians the "High-Tension" Congress, not merely because we have accustomed ourselves to talk freely about voltages ranging from 10,000 to 100,000 as if there were no difficulties at all about insulation, but we have been living at high pressure all the time, either at the sectional meetings or in restaurants and theatres. On Tuesday, the 8th inst., M. von Dobrowolsky gave a lecture on "The Electrical Transmission of Power by Means of Alternating Currents," in which he reviewed the question in an able manner, the gist of which, however, is now well known to readers of the ELECTRICAL REVIEW. The lecturer drew a distinction between theory and practical results where alternating currents are concerned; the creation of magnetism and difference of potential are not simultaneous, they lag one behind the other; from this it may be concluded that the alternating current is the result of two currents, viz., the exciting current, and another which he terms the "watt-current." The frequently-debated question whether an alternator has self-induction can only be answered for each individual case or type of machine. Well-constructed synchronous motors, whether uniphase or multiphase, can be brought to a high efficiency by comparatively simple means. Also unsynchronous motors (Drehstrom) work very economically when supplied with three or more currents; they require more iron, nevertheless they have a good efficiency. M. von Dobrowolsky chooses a low number of alternations, 30 to 40 per second, except in the case of parallel working with condensers.

During the discussion,

M. Deri, of Budapest, called attention to the work of Prof. Ferraris, of Turin, who in 1885 produced an apparatus with a rotating field, and published in 1888 his theory which formed the basis of all the multiphase machines constructed since then by Mr. Tesla and others.

M. Korda, of Paris, remarked that the French electrician, M. Leblanc, had also constructed a multiphase motor, but which required only two wires for transmission.*

Dr. S. P. Thompson was of the opinion that the three-phase motor is superior to the ordinary alternating current motor in three distinct points; firstly, it is self-starting; secondly, it gave a smaller loss of efficiency with the same weight of copper; and thirdly, it had a uniform field. The fact that three wires are necessary need not be considered a serious disadvantage when reference is made to the copper section.

Mr. Gisbert Kapp called attention to the usefulness of Arago's disc for purposes of demonstration, especially for illustrating the multiphase motor principle in schools. He wished to emphasise the facts that this system permits of any transformation in stationary transformers, and that the mechanical construction is so perfect and simple, congratulating, at the same time, M. von Dobrowolsky and Mr. Brown upon the high-class engineering design and workmanship displayed in the generator and motor used for the Lauffen transmission.

Mr. Strecker, of Berlin, read a paper on "A Time Indicator for Telephones." The present system of charges for the use of telephones, by annual subscriptions, appeared to him unjust, inasmuch as some subscribers speak often and much, whereas others use the telephone only occasionally. He suggested payment according to time. For this purpose the German telephone offices devised an electrically-driven clock attached to each telephone, which will work as long as the telephone is off the hook, and stops directly the same is replaced at the end of a conversation. By this means subscribers could lend their telephones to other persons, and charge them according to the use made of the instrument. Unnecessary conversations can thereby be prevented, conversations limited to a reasonable length, and the useful efficiency of the whole installation augmented.

Dr. Julius Maier mentioned that a method for counting the number of conversations had been adopted in Stockholm and in Dundee. Director Jaite, of Berlin, came to the conclusion, from long experience, that the useful telephone traffic is hindered by useless conversations.

Mr. Grawinkel, of Berlin, read a paper on "The Use of Accumulators in Telegraphy," and advocated their adoption in preference to primary batteries. He made no reference to the fact that secondary batteries had long been in use in the London Post Office, and that, on account of the success attained so far, the whole of the telegraph lines between England and the continent will shortly be worked with accumulators. Mr. Preece intended to read a paper on this subject, but abandoned this intention, partly because it contained similar statements and partly on account of pressure of time, the hour to adjourn this meeting having been announced.

In Section V., "The Laws affecting Electrical Enterprise" were discussed by the special committee, and a series of resolutions were framed for the purpose of having them adopted by a general meeting. These are scarcely of sufficient interest to English electricians, since they refer principally to the anomalies or shortcomings in German law.

The Congress attended a special performance of the ballet, "Pandora," in the Victoria theatre, which ballet gives peculiar opportunities for electrical stage displays.

In the evening the members joined in taking supper in the large restaurant of the exhibition.

Wednesday, the 9th, was a busy day.

Dr. Voller, of Hamburg, read a paper on "A Method for Demonstrating and Investigating Electrical Waves in Wires." Those who have followed Prof. Hertz's discoveries will know how many difficulties he had to overcome. It has been observed that waves of varying amplitude are developed in the same wire, and this caused the difficulty in determining the loops. Lechler, of Vienna, made an improvement in the method of experiment by connecting two wires at any convenient point through a bridge, and he thereby divided the conductors into two parts. In the first half a wave of great length was created, and this was transmitted to the second half through resonance. By moving the wires of the bridge, both ends of the wires connected to a Geissler tube could be brought to glow more or less brilliantly. The glow was strongest when the loop happened to be in the loop. By shifting the tube along the wires three

* ELECTRICAL REVIEW, August 14th, 1891, p. 206.

distinct waves could be observed. In order to demonstrate the analogy with acoustic effects, the two insulated ends were joined with a conductor, when four distinct waves were shown.

During the discussion, Dr. Jaeger mentioned that Mr. Stephan, of Vienna, is now engaged with investigations of electric waves. Contrary to Maxwell and Hertz, he follows Neumann's theory. He also came to results which did not support the idea of transmission on the surface.

Prof. Moeller, of Brunswick, had been studying the motion of waves for the last 17 years, and he had arrived at a new theory. The same was based upon three laws in dynamics: 1. The statical pressure caused by a mass upon the unit of surface of a medium is proportional to the free energy within the unit of space. 2. The pressure within a closed space is equal to the same of the statical pressure and the pressure of waves in an elastic medium. 3. In ether the electrical potential diminishes, and in air the sound potential is diminished by the free propagation of waves, according to the distribution of the force.

At five in the afternoon the members of Congress, with a number of ladies, assembled in the spacious hall of the Palm Garden.

Dr. Werner von Siemens presided, and in a speech expressed his delight at seeing such a large assembly of distinguished men from all parts of the world taking part in their international fête. Electricity, the venerable speaker said, is the child of this international century. International was its birth, and international were those who fostered and developed it. Electricity had bridged the space which separated nations, and it has joined them in the common work of the development of the science of this era, a science on whose threshold we stand, and from which the greatest blessings for humanity are hoped for. Dr. von Siemens called upon the guests to give a threefold "Hoch" for the Emperor William II., the protector of art and science, the strong supporter of the World's peace. This toast was heartily responded to amidst the strains of the National Anthem.

Prof. Ferraris, of Turin, speaking in Italian, proposed the health of the inhabitants of the city of Frankfort.

M. Gerard, in well chosen French, gave the toast of Dr. von Siemens and Dr. Silvanus P. Thompson, proposed in his native tongue, "German science." Judging by appearances, and the enthusiasm shown after fitting sentences, one was led to think that the majority of those present were conversant with three or four languages.

M. Hospitalier, of Paris, and Dr. von Waltenhofen, of Vienna, each thanked the committee, in the name of his countrymen, for the cordial reception given to them.

On Thursday, the 10th inst., the meeting discussed the proposed adoption of "henry" as the unit of induction, and the whole question of nomenclature was put into the hands of a special committee.

M. Hospitalier suggested a uniform method of symbols to be used in electrical science; also the coining of new words to express new phenomena, such as an international equivalent for the German word "Drehstrom," and other matters.

Dr. Oscar May, of Frankfort, read "Rules for Electric Installations from the Fire Insurance's Point of View." Hitherto various rules had been framed by different insurance companies, but there was no uniformity about them. It would not be difficult to arrange rules to satisfy all the companies, if they are based upon sound principles; but they should not embrace minute details, giving the installation contractor a certain amount of latitude. Such portions of an installation which are under the care and supervision of engineers, the ordinary precautions against fire should suffice. It ought to be prohibited to enter an accumulator room with a naked light. Uncovered wires should be placed 30 centimetres apart, and well insulated wires, a distance of 2·5 centimetres from each other. Great attention should be devoted to soldering joints. Glow lamps should not be suspended from the leads carrying the current. Cut-outs, with the exception of the main cable, ought to be double-pole throughout all branches, and the normal working current to be stated on each fuse. All safety appliances must be perfectly automatic, rapid in action and well covered.

Dr. Hoepfener, of Giessen, read a paper on "Electro-Chemistry and Metallurgy," referring principally to the improvements in the production of pure copper. He described his process of obtaining pure copper from the ore by means of a solution which dissolves the ores, and which is then electrolytically decomposed, when copper is deposited. With this process 50 to 60 kilogrammes of copper can be produced per hour with one horse-power.

Dr. Otten, of Homburg, lectured on "The Application of Electricity for Mining," giving prominence to the work done by the Thomson-Houston Company in America.

Dr. Silvanus P. Thompson read a paper upon "A Few New Electric Mining Machines," similar to his paper at the recent meeting of the British Association.

"The Determination of Magnetical and Electrical Work in Iron Armature Cores" formed the theme of a lecture by Mr. Hummel, of Nuremberg, which offered little value, since his own method is still in course of development; indeed, it was difficult to follow the reasoning without experimental illustrations. Prof. Weber, of Zurich, criticised Mr. Hummel's method, and there was a kind of word-duel upon the platform, which gave the proceedings a somewhat undignified air.

Dr. C. Heim, of Hanover, gave a lecture on "The Testing of Accumulators," in which he said little that is not already known in this country.

Splendid weather favoured the fête and illuminations of the river Main in the vicinity of the Exhibition, which took place in the evening; steam boats, electric boats and rowing boats, decorated with Chinese lanterns, and Bengal lights, formed an interesting procession on the bright river, the search light on the lighthouse bringing the moving objects into prominence from time to time. The excellent singing of a glee society on board a large steamer was well appreciated and enthusiastically applauded.

The fourth day of the Congress opened with a description of the phonopore, by Dr. S. P. Thompson, whose enthusiastic hopes for the future of this instrument were considered a little too optimistic.

Mr. Gisbert Kapp read an interesting paper on "The Experimental Determination of the Losses by Foucault Currents and Hysteresis in Dynamo Machines." It is of great importance for the electrical engineer to determine independently the losses through eddy currents in copper and iron, and the waste of energy occasioned by magnetic friction (hysteresis). Mr. Kapp gave a method which is suitable for armatures of continuous current machines, and he maintained that it is even more important to know these factors than to know the efficiency of a dynamo, and he even suggested that dynamo makers might with advantage enter those losses in a separate column of their price lists. The losses vary with the load, and it is useful to determine them at different outputs and plot the values in order to obtain curves. Unfortunately there are always two machines necessary for this purpose, and they are sometimes not available.

M. Lahmeyer lectured on "New Constructive Details in the Domain of Multiphase (Drehstrom) and Continuous Current Apparatus," giving an account of a method of suppressing sparks at the commutators of high tension continuous current machines. This he does by introducing a resistance between the armature bobbins and the commutator segments, and he thinks it probable that machines of much higher tension than hitherto will be built. Continuous current transformers, with high and low tension windings on the same armature, were subject to short circuits between the neighbouring coils; the sparking across might be avoided by the introduction of a kind of lightning conductor between the coils. M. Lahmeyer did not think that continuous current working will go to the wall on account of the introduction of the multiphase system, which found its first practical construction in the hands of M. Haselwander in the year 1887. The multiphase system had its disadvantages, the most important of which were: 1. That sub-division and distribution was difficult. 2. That it cannot be used for electric railways. Its advantages were: 1. Extreme simplicity. 2. The possibility of starting the motors with full load. 3. When compared with ordinary alternate current machines they need not be synchronous. Very little was known about the efficiency of the multiphase system.

During the discussion, M. Deri spoke against this system, pointing out that the regulation and sub-division of the current was only possible at a considerable sacrifice of efficiency. It required three leads, which is a disadvantage in itself; moreover, these leads must not be put into metal tubes for underground work, on account of induction.

M. von Dobrowolsky replied to these attacks against the

multiphase system, and said that regulation is not only possible but comparatively easy; furthermore, the system was quite free from induction. Referring to the three conductors, he contended that the quantity of copper used to convey the same energy was not greater in the Drehstrom system than in the two-wire alternate current system. Given two wires of 150 millimetres sectional area each for the one system, the other would require three wires of 85 millimetres section in order to present the same capacity.

M. Georges gave a theoretical dissertation on "Results of Some New Investigations with Alternate Current Motors." He spoke of the use of continuous current motors worked from alternating currents, and pointed out the present difficulties with such arrangement.

M. Du Bois Raymond discussed the last two papers, and referred to the theory of M. von Dobrowolsky, with which he could not quite agree. In the case of the multiphase motor, complicated magnetic interferences must occur between the neighbouring bobbins of the stationary ring or armature.

Dr. Zerener, of Berlin, described his system of "Electric Tanning." There are several methods of treating the skins with continuous currents acting upon the tanning liquid; but hitherto attempts had failed to produce the desired effect upon very thick skins. He found that alternating currents gave results which are very promising. The number of alternations used were 6,000 per minute, with a current of 44 volts and 25 ampères, for heavy skins, requiring five hours' treatment per day for 30 days. Experts have pronounced the leather of excellent quality. The amount of energy expended was 2·1 H.P. for 60 large skins.

Prof. Weber, of Zurich, gave one of the most interesting discourses during the whole Congress, entitled "General Theory of the Electric Incandescent Light." The learned professor has for years past experimented to determine the relation between temperature and wave length, properties of the material and luminosity, a law of radiation; and he had also studied in connection with the glow lamp. Until now there has not been any means for determining the temperature of the filament, but he had succeeded to find the same within small fractions. Of 33 different kinds of incandescent lamps which were investigated, the temperature was about 1,570°, varying at most 10°, at their normal candle-power. By lowering or raising the candle-power the temperatures varied from 1,400° to 1,600°. Prof. Weber showed that the efficiency of lamps, viz., energy divided by candle-power, does not depend upon the quality of the carbon filament, and is constant for all lamps, no matter what kind of carbon. But variations in the temperature appeared when filaments were worked up to a point approaching evaporation, and these varied in three samples between 1,603° and 1,611°. The professor intends making similar experiments with arc lamps.

This day closed with a visit to the Opera, where the principal scenes from "Excelsior" were given, and afterwards, at the invitation of the Frankfort Electrotechnical Society, the members of Congress adjourned to a grand "commers" to celebrate the tenth jubilee of the society. Only those who have lived in this part of the world can fully appreciate the meaning of a "commers," or, as the students have it on a smaller scale, the "kneipe."

The fifth day of Congress was opened at the usual hour, 9.30 am., in the theatre, by Dr. Kittler, of Darmstadt, who laid before the meeting the resolutions of the committee on laws affecting electrical enterprises. These resolutions were passed *en bloc* and *nem. con.*

Prof. Weber reported upon the work of the commission dealing with nomenclature and symbols. It was proposed to use, for denoting dimensions, letters in italic; for units, Roman letters, and for constants and angles Greek letters. The following electrical units—ampère, coulomb, farad, joule, ohm, volt and watt to be expressed by their initial letters. The proposal of the American Institute of Electrical Engineers to adopt the "henry" in lieu of "gauss" and "weber," or either of the latter, to express the unit of induction, has been withdrawn, and referred to a decision to take place at Chicago. At some future international congress, these propositions will be further considered.

Herr Zipernowski, of Budapest, next read his paper on "Electric Railways for Interurban Rapid Transit," which we are reproducing but which deserves severe criticism, not on account of the boldness of its conception, but for the errors in calculation and judgment. Railway engineers, especially, will find Mr. Zipernowski's figures as to the horse-power required for the given speed weak. In the first place the project is not to be carried out, and secondly, if there were the least chance of its consummation, it would have to be modified very much.

Dr. Epstein's paper on "The Position and Duty of Electrical Testing Establishments," referred to the necessity of public testing institutions alike to the small as well as the larger manufacturing firms; the latter often avail themselves of independent investigations, in order to give the world the unbiassed opinion of disinterested experts. The main object of Dr. Epstein's paper was not to lay down rules for conducting public testing rooms, but to obtain the views of members present with reference to such establishments.

Dr. Heim opened the discussion by saying that the number of such institutions in Germany is too small to form an opinion as to their relative value.

M. Loewenherz thought that an augmentation of testing rooms will relieve the Government office existing for such purposes; but it is of the utmost importance that such establishments are absolutely independent.

Dr. Weber, of Munich, emphasised the fact that "opinions" of such institutions should not be made an object of exhibition or advertisement.

M. Uppenborn, on the other hand, advocated investigations on the relative merit of different inventions or processes; but that much "tact" should be employed under all circumstances.

Prof. Kohlrausch pointed to the usefulness of the Imperial testing establishment.

Mr. Wielting spoke on "The Use of Accumulators in Combination with Alternating Plants," suggesting the employment of transformers which convert alternating into continuous current, for purposes of distribution and charging batteries.

M. Baumgardt read a paper on the "Relative Economy between Compressed Air and Electricity," and advocated the combination of both systems. No discussion followed, indicating that the interest in this question exists no longer.

Mr. Guttmann, of New York, treated "The Practical Application of the Rotary Field System," commonly called "Drehstrom," criticising the choice of this expression. He next referred to the practical work of Tesla in America, who made plants up to 50 H.P., but that the high price of transformers had been in the way against a more rapid development of this system. According to Mr. Guttmann's account, Mr. Tesla is now engaged upon a new kind of alternating current motor which is supposed to be as good, if not superior, to anything at present in the market.

After referring to some critical remarks made by the readers of the paper, Mr. Lindley, of Frankfort, said that the results of the tests with the Lauffen plant, to be made by the testing committee of the Exhibition, will be published in full.

M. Pfuetzner, of Berlin, described "The Process of Producing Electrolytic Copper" as now adopted by Messrs. Siemens and Halske, from copper ores. From ores containing only 4 to 4½ per cent. of the metal, one ton pure copper is obtained with an expenditure of only 125 horse-power.

The paper of Dr. Julius Maier, on "State or Private Working of Telephone Lines," was to the effect that it is in the interest of public welfare that telephones as well as telegraphs should be in the hands of Governments.

Dr. Holborn, of Charlottenburg, spoke on "The Magnetic Behaviour of Different Iron Alloys," showing with curves the results obtained with various samples, and he called special attention to the question of tempering and hardening, which played an important *rôle* in steel magnets, but which had not hitherto been sufficiently appreciated.

Dr. Bruger exhibited an instrument made by Messrs. Hartmann & Co., which had for its object the measurement of a magnetic field, and which was based upon the conductivity of bismuth when placed within a magnetic field. He afterwards gave a lecture on "The Application of a Few Instruments for Measuring Alternating Currents." Good instruments for everyday use were still a desideratum. The Cardew voltmeter was the only voltmeter at present sufficiently reliable for alternating currents, although it

did not come up to the accuracy of continuous current instruments. Dr. Bruger, in order to determine the applicability of several continuous current voltmeters for alternating currents, made a series of experiments as to their behaviour, and he found that the observed values lagged behind the values obtained on the continuous current circuits to the extent of from 16 to 30 per cent. Tests with different arrangements of instruments containing electromagnets showed that it is possible to reduce this difference to 1·1 per cent. Hitherto it had been assumed that it is necessary to employ as little iron as possible in the construction, but this is an erroneous idea.

"Materials and Construction of Measuring Instruments" formed the theme of a paper by Dr. Feussner. It had been the custom to use, for resistances in rheostats, German silver, whose conductivity is not quite independent of temperature; besides, at high temperatures, molecular changes occurred within the body of this alloy which has the effect of dividing the metals. This is probably due to the zinc therein. Experiments had then been made with alloys of nickel and copper leaving zinc out altogether, which gave exact indications of the dependence of the specific resistance and the coefficient of temperature, upon the structure of the alloy. These results were so exact that it was possible to determine the chemical constituents by measuring the coefficient of temperature. With 40 per cent. nickel it is zero, then it becomes a negative quantity, with 48 per cent. again zero, and then a positive value. The production of this alloy, which is due to Messrs. Constantan, offers no difficulty.

Dr. Kahle, of Charlottenburg, spoke upon "The Limits of Errors in Measuring Instruments, due to Heating, Residual Magnetism, &c.," and related the experiences of the Imperial testing establishment with 24 instruments from eight different makers, wherein considerable variations in the indications could be observed.

M. Flochenegg, of Vienna, discussed "Graphic Representations of Electric Circuits," and suggested a method for showing the maximum losses of pressure between branch circuits by means of similar triangles.

The evening of the fifth day was spent at a social gathering at the Zoological Gardens, where the members attended, first at the open-air concert, and later in the large hall, and indulged in dancing, there being an abundant number of ladies, who contributed energetically to the general enjoyment.

Saturday was spent in a visit to Wiesbaden. Delightful weather favoured all the proceedings of this Congress, which will long be remembered with pleasure by the majority who took part in it.

The Excursion to Lauffen.

The 7.10 a.m. express train, on the 14th inst., contained three parlour cars carrying a number of favoured guests of the Allgemeine Elektricitäts Gesellschaft and the Oerlikon Works. Among the foreign element of this interesting concourse were M. Marcel Deprez, Mr. Preece, Prof. Ferraris, Dr. S. P. Thompson, Dr. von Waltenhofen, M. Turrettini, Mr. Gisbert Kapp, Mr. Kareis, M. Hospitalier, Captain Holden, Mr. A. Reckenzaun, and many others. All along the route, parallel with the railway but on the opposite side of the telegraph lines, were the posts supporting the three wires of the Frankfort-Lauffen electric transmission of power. As is already well known, the line covers a distance of 175 kilometres, but the occupants of the train had the opportunity of convincing themselves of this fact by actual observation. Lauffen, a picturesque ancient village on the lovely river Neckar, was reached at 11.30 a.m., and there the party was received by the heads of the Wurtemberg Government, among whom was the Minister of the Interior. The streets were decorated with flags, and lined with the whole population when the company marched from the railway station to the Portland Cement Works, half a mile distant. There, in front of the dynamo and transformer, M. Oscar von Miller made an impressive speech, in which he referred first to the work of Marcel Deprez at Munich in 1882, which was the earliest attempt to transmit power electrically to a considerable distance, and operate an electric motor. It was necessary, however, to adopt currents of high pressure, in order to transmit economically a considerable amount of energy to great distances.

The present demonstration was not easily arranged; it was exceedingly difficult to find men sufficiently enterprising to undertake a work of such magnitude as this at Lauffen, but Mr. von Miller was happy to persuade M. Rathenau, of Berlin, and Col. Huber, of Oerlikon, to tackle this gigantic problem. The results are now known; the question of transmitting the energy on this large scale is an unqualified success. The speaker acknowledged also the great merit due to Mr. Brown, of Oerlikon, and Mr. von Dobrowolsky, of Berlin, who jointly designed and erected the machines and transformers now on view. This great work is an international work, one which will benefit the world at large.

At the conclusion of Mr. von Miller's oration, which was enthusiastically applauded, the turbines and dynamos were started, and the various details more minutely examined.

A splendid dinner followed, at which toasts were proposed by his Excellency the Minister of the Interior, Mr. Rathenau, who reviewed the history of the enterprise, and expressed his conviction that at no distant date we shall be working with a tension of 100,000 volts.

Col. Huber thanked the authorities of the Exhibition for initiating and encouraging this undertaking.

Mr. Sonnemann thanked, in the name of the committee, the distinguished foreigners for their presence.

Dr. S. P. Thompson proposed the toast of the Governments who assisted in promoting and carrying into effect the Lauffen transmission.

M. Marcel Deprez spoke of the merit due to the manufacturers of the plant, and to the men who conceived the ideas of this multiphase system.

Dr. Arndt, in conclusion, thanked the host and hostess, Mr. and Mrs. Rathenau, for their excellent hospitality on this important historical occasion.

It was an interesting sight, a significant occasion, which all the partakers will long remember with intense pleasure.

THE NATURE OF THE SPARKS IN THE ELECTRIC VIBRATIONS OF HERTZ.*

BY ED. HAGENBACH BISCHOFF AND L. ZEHNDER.

IN recent years there have appeared a number of researches, principally by H. Hertz, with the purpose of supplying an experimental proof of the correctness of the view of Faraday and Maxwell, according to which the *actio in distans* of induction is to be interpreted as energy transferred in the form of waves, as is the case with sound, with light, and with radiant heat. These important researches have excited the greatest attention, as hereby the connection between light and electricity, so long sought for, obtained a perfectly definite form, and the difference between luminous radiation and electro-magnetic radiation was essentially referred to the different magnitude of the numbers of undulation. We have undertaken to examine whether the phenomena of electric undulations, in so far as they are accessible to experiment and measurement, necessarily compel us to accept the new views, or if they may not be explained in a perfectly satisfactory manner by the well-known and universally accepted laws of induction. In the first place we repeated the very interesting experiment with parabolic mirrors, fig. 1, exactly as described by Hertz (*Wiedemann's Annalen*, xxxvi., p. 769), and whilst in many points we found his results accurately verified, we still encountered phenomena which the analogy between luminous and electro-magnetic radiation did not lead us to expect. Thus it greatly struck us that in several of our experiments a plate of sheet metal annulled the formation of sparks in the secondary conductor just as well if it was introduced in a longitudinal as in a transverse position.

We soon arrived at the conviction that a correct insight into the occurrences in the primary and the secondary conductor is possible, only if the observation of the sparks is controlled by experiments with electrical measuring apparatus. For

* *Repertorium der Physik.* Vol. xxvii., p. 496.

these investigations we used, at first, electroscopes specially constructed for this purpose, with their aluminium plates, the movements of which were read off by means of a microscope provided with micrometric eye-piece. Although this manner of observation did us much good service, and among other things, permitted us to examine the influence of the prolongation of the secondary action upon the periodic increase and decrease of the phenomena of induction, we have abandoned it, as manifold disturbing influences obscured the results, and resorted to the ordinary measuring instruments; our hopes that these would answer the purpose have been amply fulfilled.

FIG. 1.

Electric Phenomena in the Primary Conductor.—In our experiments we assigned to the two halves of the primary conductor, between which the sparks strike over, the exact form and size employed by Hertz. As an exciter we used a Rhumkorff apparatus, the induction coil of which was 35 cm. in length and 15 cm. in diameter; the interruption of the current, which was supplied by three accumulators and had a strength of about 20 ampéres, was effected by a Deprez interrupter which oscillated to and fro very rapidly.

Although the theory of these large induction-tubes is known in general, we found it necessary to give by experiments a firm foundation to our views on the occurrences in the primary conductor. The extra-current, the condenser and the interrupter cause the current running through the inducing bobbin to rise slowly, to remain constant for the shortest possible time, suddenly to fall to zero, and then again to rise slowly and so on, as shown by the next figure, in which the abscissæ represent time, and the ordinates represent the intensities of the current, T. Every change of this strength and current excites in the induction coil an electromotive power, E, proportional to the magnitude of this change, $d\,T/d\,t$. This is shown by the lower curve, fig. 2, in which the abscissæ represent equal times, and the ordinates values of E, proportional to the differential quotients of the upper curve.

If now the induction coil is closed by a conducing wire, it is traversed by induction currents in opposite directions in accordance with the closing and opening of the inducing current. We name the intensities of the induction currents J. As they are equal to the surfaces, A and B, corresponding to the values of E, $d\,t$, then if the resistance is constant, the integral currents J, $d\,t$, passing in both directions have an equal value, *i.e.*, upon the whole, an equal quantity of electricity flows to the left and the right.

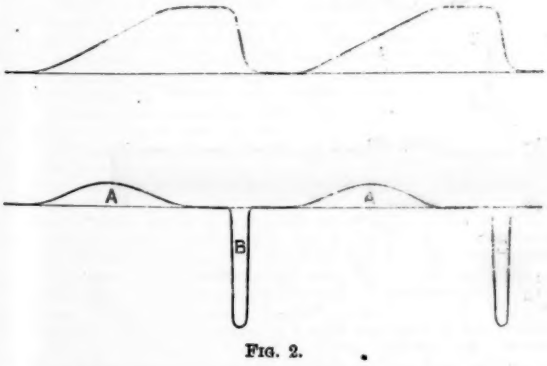


FIG. 2.

Hence, the needle of a slowly vibrating galvanometer, if introduced, gives exactly equal strokes to the left and the right. But if on inserting the interrupter the interruptions follow each other with sufficient rapidity, the needle of the galvanometer cannot follow the antagonistic impulses, and it therefore remains in its position of rest, only at the commencement there appears a deflection to one side, and at the end, one on the opposite side. But, as the curve shows, the two currents are very different as regards the tension which they can present to overcome a resistance; the induction current which corresponds to the opening of the main current has the stronger tension, and that which corresponds to the closing has the weaker tension; thus *e.g.*, in our apparatus the current, on opening, was able to strike to a distance of 40 mm., whilst that on closing could only overcome a distance of 0·13 mm. If, therefore, we introduce into the induction-current, a spark-distance, the galvanometer shows a deviation corresponding to the direction of the opening current which appears on inserting the spark-distance, which first increases as the distance is extended, reaches a maximum and then again sinks to zero, when the distance has become so wide that the spark can no longer spring over. An action of the low-tension closing current in the opposite direction is obtained by an arrangement in which the opening current partly discharges itself through the spark-distance, and, therefore, the closing current predominates in the galvanometer. As a matter of course, this experiment succeeds only if the spark-distance is small and the resistance in the by-circuit of the galvanometer is great.

In the primary conductor used in our experiment, the distance of the electrodes in the spark-distance was nearly 4 mm., we are therefore justified in assuming that only the opening current could overcome it and that the electricity could pass over in this *one* direction only. This one-sided transition of electricity is very distinctly manifested in the Priestley figures produced by the transfer of matter and of oxidation, as only the positive side shows the black knobs, whilst the negative side displays the coloured rings.

To each opening of the main current there corresponds, therefore, *one* spark springing over in a quite determinate direction, which, however, as the following consideration shows, may under circumstances be composed of several partial discharges in rapid succession. If for a given spark distance we assign to the two halves of the conductor such capacities that the electricity flowing from a single opening current is exactly sufficient for a charge of the potential necessary to overcome the spark distance, then only *one* spark will spring over. But if the two electrodes are brought to a smaller distance, a smaller potential difference, and in consequence, only a smaller quantity of electricity will suffice for the spark to spring over. The quantity of electricity supplied by the opening current will suffice to charge the two halves of the primary conductor up to the springing point of a spark several times in succession. The number of these partial discharges increases as the spark-distance diminishes, and they would follow each other at equal intervals of time if the electromotive force of the induction coil by which the conductors are charged were constant; that, however, occurs at

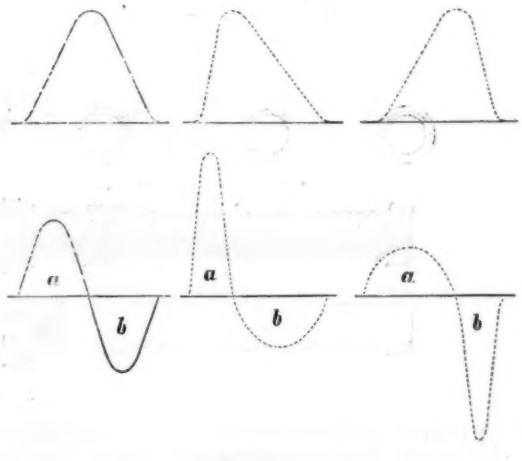


FIG. 3.

most during the short time of the maximum action; as long as the electromotive force increases the intervals decrease, and as long as it decreases the intervals increase; fig. 3 shows these variable intervals of time.

The circumstance that the spark-distance may become more conductive by the previous partial discharges may render a lower tension necessary for further such partial discharges, and that especially as the spark-distance becomes less, more and more of the electricity furnished flows off directly, and hence does not contribute to raise the potential. In this manner the breaking up of the discharge may be much affected. Self-induction will also play here a part. We will not discuss in how far such successive partial discharges, in which the spark corresponding to the opening current is broken up by the limited capacity of the primary conductor, can be called "undulations." We permit ourselves merely to remark that as far as we are acquainted with investigations on this subject, the reciprocal passage of electricity corresponding to the deflections to opposite sides, is as little proved by direct experiments as the equality of the intervals of time, both suppositions which we are accustomed to regard as self-evident in sound and light-undulations.

The decomposition of the spark into partial discharges plays, as we conjecture, a main part in the phenomena of so-called "resonance," but as we purpose examining this important point more closely, we do not enter upon it for the present.

Electric Phenomena in the Secondary Conductor.—We will now consider the inductive action which a unilateral discharge of sparks must produce in the primary conductor according to the laws of induction as universally admitted. We pass over at present for the sake of simplicity the above-mentioned decomposition of the spark into partial discharges and we assume that the electricity springs over only once. The intensity, I, of this stream of sparks will reach a maximum within an extremely short time and will immediately afterwards sink back to zero; $d\,\mathrm{I}$, $d\,t$, acquires therefore a very high value and will consequently excite in the secondary conductor a relatively great electromotive force, e; to the growth of the intensity I, *i.e.*, to the origin of the spark there corresponds an electromotive power $+ e$, which tends to produce a current in the opposite direction and to the decline of intensity I, *i.e.*, to the disappearance of the current there corresponds an electromotive force $-e$, which tends to produce a current in the same direction.

In the upper curves, the abscissæ represent the time, t, whilst the ordinates give the intensity, I, they consequently give the law according to which the stream of speaks varies with the time. In the lower curves, the abscissæ have the same signification and the ordinates indicate the electromotive forces, e, produced by induction in the secondary conductor. In the produced line we have assumed that I increases and decreases symmetrically, whence the corresponding $+ e$ and $- e$ are equal. Generally, this will not be the case, and I will either increase rapidly and decline slowly as in the dotted line, or else it will increase slowly and decrease quickly as in the continuous line, involving corresponding modifications in e. Thus all possible forms of curves are conceivable; still the contents of the surfaces a and b corresponding to $+ e$ and $- e$ will remain respectively equal.

Every primary spark therefore excites in any conductor in the vicinity two such antagonistic electromotive forces in rapid succession; consequently, in every secondary conductor if no sparks spring over, an exactly equal quantity of electricity will move in each direction. As two such opposite integral currents exactly equal in value follow each other in an extremely short time, it is quite conceivable that measuring instruments such as the galvanometer, or the constantly charged electrometer, in which opposite currents act in antagonism, do not show the slightest effect.

The process takes quite a different turn as soon as a space for sparks is introduced, which, under certain circumstances, acts as a valve and permits currents of high tension to spring over more readily than those of low tension.

In our very numerous experiments we first employed, like Hertz, a secondary conductor of copper wire, and afterwards we substituted two brass plates of 0·5 mm. in thickness, 5 cm. in breadth and 50 cm. in length; the interval for sparks was introduced between the two halves and connected with the inner ends of the halves of the conductor by copper wires, each 37 cm. in length. The dimensions, both of the conductor and of the connections with the spark interval, are of decisive influence on account of resonance, as Hertz has shown. We have, therefore, sought to obtain by experiments the most favourable condition, taking especial care that everything on each side of the spark interval was exactly equal.

Especial attention was given to the completest possible insulation of all parts of the secondary conductor, as also to the linear conduction from the brass plates to the spark interval. Here, also, bilateral symmetry was observed, and whilst in the preliminary experiments we, like Hertz, used on the one side a rounded surface and, on the other, a point, in our definitive experiments we placed over against each other two rounded platinum wires 2·2 mm. in thickness and of the form shown in fig. 4, and we varied and measured the distance

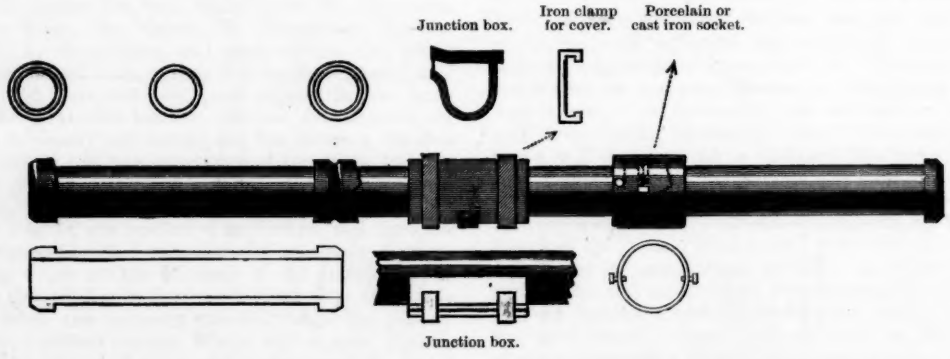
FIG. 4.

between these electrodes by means of an insulated micrometer screw.

(To be continued).

FARQUHARSON'S SYSTEM OF UNDERGROUND ELECTRIC LIGHT CONDUCTORS*

IN this system (devised and patented by Mr. J. Farquharson), instead of putting insulating materials on the conductor, or supporting the conductors at intervals by insulators, as is usually done, the + and — conductors are placed in separate tubes of insulating material of such size that additional conductors can be drawn in afterwards as required. The insulating tube for containing the conductor is made of porcelain, of the description used for drain pipes, of the best description. As an additional precaution against minute defects, the pipes are painted with bitumen, or other non-conducting material. The tubes are made in short lengths, with an external rim or collar, parallel on one end, and with a skew edge on the other. In position, the pipes are placed end to end, with a gromet of jute or cotton between. Over the joint a cylindrical ring, or cylinder of porcelain is placed, with a hole in



the middle, and two near the ends on opposite sides; a pin of hard wood, projecting inwards, is put in the end holes, so that by turning either the cylindrical ring or the pipe with the skew collar against the pin, the joint is closed on the gromet; the joint is completed by stopping round the ends

* See article on Underground Conductors, by A. Stuart Russell, in ELECTRICAL REVIEW, March 13th, 1891.

of the ring with Portland cement, and pouring hot asphalt over the joint through the hole in the centre of the ring, completely filling the space between the pipe and the ring. In places where heavy weights are passing over, requiring greater strength, rings of enamelled iron are placed over the joints.

Another part of the system is a junction box for branch connections. The box is made of porcelain, and the same length as the pipes, with joints at the ends, made in the same manner. It is slightly enlarged in the middle, and provided with a flanch seating and cover of the same material.

The figures show the various parts of the system.

PUBLIC LIGHTING IN EASTERN EUROPE.

THE French Government having desired its consuls in the principal towns of the east of Europe to report on the public lighting of those places, the representatives of France have furnished particulars on that subject, which are published in the *Moniteur Officiel du Commerce* for July 9th and 16th.

According to these reports, it appears that there exists no manufactory of lighting apparatus in Roumania, with the exception of one recently founded in Bucharest, and this, at present, does no more than produce wick-holders for petroleum lamps; the cylindrical glasses for the same are principally made at the glass works of Azuga.

It is intended to make lamps in the Bucharest factory, and before very long it is probable that the whole apparatus for lighting with petroleum will be manufactured at least at one place in Roumania. With the exception of certain small accessories, everything connected with lighting by means of gas has to be imported into Roumania from abroad. Most of the lamps now used in that country are furnished by makers in Austria-Hungary, mainly from Vienna and from Budapest. Lamps are also imported, but in much smaller quantities, from Germany. There is no gas used in any town of Roumania except Bucharest. Everywhere else simple petroleum lamps are used, and the town of Galatz is lighted by 1,695 of these. At Jassy the theatre and the circus have lamps of vegetable oil, but everywhere else petroleum is used in glass lamps with a straight wick. For domestic lighting lamps of all dimensions are used, with burners and circular wicks, all which lamps are imported from Austria or Germany.

When we turn to Servia, we find that Belgrade, the capital, contains no manufacturer of illuminating apparatus. The streets are lighted by a few petroleum lamps with reflectors, and when the municipality has need of a supply of lanterns, it applies to the Jewish tinmen, who produce what is required. Nisch is lighted only by petroleum lamps at certain important points of the town, and there is not even a shop devoted to lighting or lamps; the latter are ordered from Vienna or Budapest, and sold by grocers or dealers in hardware.

In Sofia, the capital of Bulgaria, there are several dealers in lighting apparatus; but there is no manufacturer of these articles in any part of Bulgaria. What is used comes exclusively from abroad, and principally from Bohemia. There is a small importation of glass lamps from Belgium. No other substance than petroleum is used in any part of the country. Lighting apparatus only figures in the Bulgarian trade reports under the head of "Glass manufactures."

The figures of the important value of these articles, in 1889, was £5,400.

In Varna, as in Sofia, petroleum alone is used for lighting. The favourite form of lamp is a cheap suspended lamp, with a single burner. There is a great sale at Varna of small lamps, specially introduced for the little towns and villages of the interior. These are made of glass, and cost about 18s. a hundred.

In European Turkey little is used except petroleum. Even in the public offices of Constantinople, into which gas had been introduced, it has been found so bad and so expensive, that it has for greater part been rejected, and petroleum taken once more into use. In private houses, as in shops, cafés and restaurants, nothing is now used but the large petroleum lamps. The electric light is employed only in the palace of Yildiz, it being forbidden by law to use it elsewhere.

The supply of lamps for Constantinople is almost entirely in the hands of Austrian and German merchants. The kinds which they supply are usually of second rate, or even inferior quality, cheapness being an essential matter. The natives are in the habit of calling petroleum gas, even when they are speaking French; but it is important to understand that they always mean petroleum. There are three French shops in Pera, and an Austrian house in Stamboul, where lamps of a better quality may be bought.

At Adrianople no gas is manufactured, and an attempt which was lately made to illuminate the city with the electric light was a complete failure. The only material used is petroleum, which is imported from the Russian establishments at Batoum. The city is lighted by very cheap lamps, on a most imperfect system, consisting merely of a cylindrical box of tin-plate, scarcely eight centimetres high, and priced at from 8d. to 9d. each.

The inside of certain establishments, such as the cafés and hotels, is lighted by lamps of a more elaborate description, from Austria or Germany. Austria inundates the country with a cheap article, devoid of all solidity of construction, but sufficient to satisfy the requirements of the Turks. The only product employed for lighting purposes in the island of Crete, except candles, is Russian petroleum oil, of very bad quality and dispersing a disgusting odour. The lamps are generally very common but very cheap. Most of them possess a glass reservoir, mounted on a stand in porcelain or metal. These are imported from Austria. No manufacturer of lighting apparatus exists in Eastern Roumelia. Petroleum lamps are used, and these can only be purchased in the capital, Philippopolis. At Bourgas, the chief port of Roumelia, all lighting apparatus has to be brought from Constantinople.

Oil is but very little used in Salonica, and consequently there is no sale for articles intended for this species of illumination. Gasworks have recently been set up in Salonica, but hitherto the number of consumers is very small. Petroleum is almost exclusively used throughout the town, and there is a considerable market for apparatus used in this kind of lighting—portable lamps of all sorts, with glass, porcelain, &c. All these articles are of Austrian manufacture and of inferior quality, but find a ready sale on account of their cheapness. A Paris house attempted, some time ago, to introduce in Salonica lamps of its manufacture, but they were not bought, as they were too expensive.

A manufacturer who wishes to sell his lamps in this town ought, first of all, to obtain information as to the price at which similar articles are at present sold there. The only form of illumination which is employed in Albania is petroleum lamps, the importation of which reaches a value of £500 or £600 a year. None are manufactured in the country, even at Janina, Scutari, or Durazzo, but are manufactured in Austria, and introduced from Trieste to ports along the Albanian coast and sold in the bazaars. In Bosnia-Herzegovina, also, gas and oil are totally unknown as illuminants, and the whole country depends on the importation of cheap petroleum lamps from Austria.

In Greece, gas is used in the towns of Athens and Corfu. In the former, everything connected with lighting by gas is supplied by a French company on the spot. In Corfu the apparatus has to be imported from an English gas company at Malta. In the rest of the country lighting is almost exclusively performed by means of petroleum lamps of Austrian or German manufacture. At Syra there exists no person who regularly sells lighting apparatus of any description, but very bad porcelain, or metal lamps may sometimes be picked up at the china or tin shops. There was once a proposal that Syra should be lighted with the electric light, but the poverty of the municipality and political reasons combined to prevent it.

Mr. T. B. Sandwith, Her Majesty's Consul-General at Odessa, writing to the Foreign Office, under date of August 1st, says that the port of Odessa, in contradistinction to the town of that name, having for many years remained unlit, even by oil lamps, and within two years only being lit by gas, has at length been illuminated by electricity. An installation has been completed at a cost of 80,000 roubles (£8,400). This consists of 64 arc lamps of 2,000 candle-power each, and of two lanterns, one at each end of the breakwater, which runs the whole length of the port. The illuminating power is generated by two of Wilson's vertical engines of 67 horse-power each. This was fully described and illustrated in the ELECTRICAL REVIEW for August 21st, 1891.

The Odessa Town Council has just assigned a sum of 20,000 roubles (£2,100) annually for the working expenses. The new installation is a great boon to the shipping interest, the whole of the port being brilliantly lighted up, so as to admit of the loading and discharging of steamers by night.

THE CHAMBERS OF COMMERCE ON TELEGRAPHS AND TELEPHONES.

DURING the recent meetings of the Association of Chambers of Commerce, the following matters were discussed:—

DELIVERY OF TELEGRAMS.

Mr. A. M. CHAMBERS (Sheffield) moved:—"That, in the opinion of this association, it is incumbent upon the Post Office authorities to give the same facilities in every respect for the delivery of telegrams as they now afford the public for the delivery of letters, and that the Department should no longer refuse to attempt to deliver telegrams in case there may be some slight error or insufficiency in the address, which would not prevent delivery in the case of a letter." Experience showed that a great many telegrams were not delivered because of very slight errors in the addresses. In one or two cases this had occurred with registered addresses, where a mistake in a single letter in a word, such as the singular for the plural or the plural for the singular, had prevented the delivery of a telegram. Other cases of non-delivery occurred where there were two persons of the same name in the same street or the same village. If only the surname was given no attempt was made to ascertain to whom the message belonged, but was returned by the Post Office as insufficiently addressed. As regarded letters, the greatest pains were taken by the department to find their destination, and letters absurdly addressed were often safely delivered. It was the experience of many commercial men that telegrams were not well treated, and they thought more trouble ought to be taken to find out to whom messages were addressed at least to the same extent as was done with letters.

Mr. E. SLATER (Leeds) seconded the resolution, and, whilst recommending that senders of telegrams should take care to assist the department by full addresses, the department should take the necessary trouble to find the destination.

Mr. COUNCILLOR JOHN HUNTER (The Hartlepools) urged the extension of means for telegraphic communication on Sundays.

The PRESIDENT put the resolution, which was carried unanimously.

TELEPHONE COMMUNICATION.

Mr. B. PLUMMER (Newcastle and Gateshead) moved:—"That as the chief telephone patents have already expired, and other minor patents will also shortly expire, thus rendering telephonic communication practically unfettered by patent rights, it is desirable that this association should appoint a committee to gain information on the subject, and make such representations to the Post Office department (which still claims a monopoly of telephonic communication) as they may deem advisable, with the view of getting the telephonic system of the country placed under such regulations as shall enable the business community and the general public to enjoy the greatest telephonic facilities at reasonable rates." Whilst having a great appreciation of the services rendered by the Post Office, they could not but regret the steps taken by the department in respect of telephones, by which they had rendered the service much dearer, and from its introduction deprived the commercial community of the benefits that would have otherwise been derived. The Post Office had adopted a dog-in-the-manger policy, and had acted in, what he considered, direct opposition to the expressed wish of Parliament. It was rather hard, as in the original Bill conferring the telegraphs upon the Post Office, they had not even a monopoly of sending telegraphic messages. The Committee of the House of Commons would not agree to the Post Office having a telegraphic monopoly. The telephone came into practical use in 1876, and the department evidently foresaw the general use of that instrument, but it had not then been introduced in England. In 1878, however, a clause was inserted in a Bill relating to the telegraphs by which the department was to be granted a monopoly in the use of "any apparatus for the transmission of messages by the aid of electricity, magnetism, or any like agency." It was thus quite clear that the Post Office experts had then begun to have a very fair idea that the telephone would be largely used, and might interfere with the monopoly of the Post Office. Parliament, however, having regard to the public interest, struck that clause out on the ground of preventing the Post Office getting a monopoly in telephones. The case on which the question of the right of the Post Office to such a monopoly was decided aroused much interest at the time in the scientific world. Mr. Justice Stephen then said that the original Act was so widely drawn, that he believed it was quite sufficient to enable the Post Office to prevent a man ringing his front door bell by electricity. He (Mr. Plummer) thought it was a great pity the case was not carried to the House of Lords, so that they might have had either a confirmation or reversal of this decision. When the original telephone company began to pay 10 per cent. dividends, the Post Office stepped in and said that in future they could only be licensees, and maintain the exchanges then established, being precluded from establishing new exchanges. Some time after that Mr. Fawcett, having been pressed very much by the company, on July 17th, 1882, said he had determined that it would be to the interest of the public for the Post Office to have a monopoly in telephonic communication; he practically conceded the view of having free trade in telephones, and said that any company with sufficient capital would get a license. The way the Post Office had carried out that free trade was that they had taken over, from the start, the old telegraph contracts for the running of lines along railways, and wherever it had been possible for the Post Office to prevent a telephone company running a line under or over a railway, they had done so. Where the Post Office had a telephone exchange they received telegrams over their wires free of charge. If he (Mr. Plummer) wanted to send a message from Newcastle to London, he had only to repeat it through the telephone, and the Post Office despatched the message. The company established at Newcastle paid £100 for the privilege of taking telegraph messages from their customers, and that was a tax equal to 15d. on every message thus sent; so that the Post Office were not only getting paid according to the number of words, but were actually receiving 15d. over and above the actual cost of the message. In the previous Saturday's *Times* the Duke of Marlborough had pointed out that in Norway the subscription for the telephone did not exceed from £4 to £4 10s. per year for the use of telephonic communication over short distances, whilst we paid £10, £12, or even £14 per year.

Mr. B. C. WATES (Leicester) seconded the resolution on the ground that telephonic communication had not spread through England at the rate that it ought to have done. Rates were too high and communication between towns too infrequent; and he trusted that the matter would now be considered with a view to the ultimate arrangement of a uniform system applicable to the whole country.

The PRESIDENT suggested that instead of appointing a committee they should leave the question in the hands of the council.

This having been acceded to by Mr. PLUMMER, the resolution was carried as follows:—

"That, as the chief telephone patents have already expired, and other minor patents will also shortly expire, thus rendering telephonic communication practically unfettered by patent rights, it is desirable that the council of this association should gain information on the subject, and make such representations to the Post Office Department—which still claims a monopoly of telephonic communication—as they may deem advisable, with the view of getting the telephonic system of the country placed under such regulations as shall enable the business community and the general public to enjoy the greatest of telephonic facilities at reasonable rates."

Telephones in Winnipeg.—The town of Winnipeg possesses a telephone exchange, which has now over 750 subscribers, being about one to every 36 of the population of the town.

NOTES.

Electric Lighting of Sofia.—The contract for lighting the town of Sofia by electricity has been obtained by Messrs. Ganz & Co. The work is to be completed in two years.

Electric Lighting in London.—We have received a circular from the Metropolitan Electric Supply Co., Ltd., giving a list of the streets in which the company have their mains now running. We notice that the principal, if not all the streets, in the parishes of St. Martin's; Strand district, Soho; Marylebone and Crown Property, Regent's Park; also the parish of Paddington, have the company's mains laid, and current can be supplied when required.

Deptford Electric Lighting.—The Electric Light Supply Corporation, who have gratuitously supplied St. Nicholas Church, Deptford, with the electric light for the last three years, have given notice that they can no longer do so, unless the arc lamps are substituted for the incandescent system. As the electric light has been found preferable to gas, in many ways, the churchwardens have resolved to make the change at a cost of 100 guineas.

Electric Light in Egypt.—In the report just published by the Foreign Office, the English Consul at Alexandria states that it is intended shortly to introduce the electric light in the Alexandria-Cairo express, and it is probable that before long the railway termini will be lighted by electricity. There is one agency for electric light established in Alexandria, but as yet only a few establishments have adopted it.

A New Battery from Bavaria.—A Munich inventor has produced a modified battery cell resembling an ordinary Leclanché in which the carbon of the latter is replaced by copper in sulphate of copper, the zinc rod being in sal-ammoniac. There is a special modification in the porous pot itself, which is prepared by dipping it, to one-third of its height, into melted paraffin wax, and then filling it with an aqueous solution of ammonia. The ammonia solution is then poured out and replaced by copper sulphate, which is in its turn poured away, and, finally, the pot is allowed to drain dry. The object of this successive dipping into ammonia and copper sulphate solutions is the formation of a double sulphate of copper and ammonium which fills up the pores of the cell, and being insoluble in either of the solutions used in the battery prevents them from mixing.

Association versus Dissociation.—There is a paper that is well worth reading in the *Berichte der deutschen chemischen gesellschaft*, by an English chemist Mr. S. U. Pickering, in which he considers the question of association *versus* dissociation in solutions. When sulphuric acid is dissolved in water, the dissociation theory represents the acid as becoming partially dissociated into ions, so that, if $x\,H_2SO_4$ be dissolved in $y\,H_2O$, the solution consists of more than $x + y$ units. On the association theory, however, the acid and water are supposed to combine together to a certain extent, so that there are less than $x + y$ units present. By its effect upon the freezing point of acetic acid, the number of acting units can according to the physical theory, be determined, and is found to be *less* than $x + y$ and less even than y alone. This, Mr. Pickering found to hold good for the weakest as well as the strongest solutions. Similar results were also obtained on using aqueous solutions of hydrochloric acid and of calcium chloride; whilst with aqueous solutions of phosphoric acid and of nitric acid, as well as with alcoholic solutions of calcium chloride and nitrate, the acting units present, although less than $x + y$ were not less than y alone. According to Mr. Pickering, the actual composition of the compounds present cannot be ascertained by this method, and if the sol vent which is frozen has a much greater affinity for the dissolved substance than the other solvent has, the depression observed in the freezing point will be practically equal to that which would be produced by the substance and the second solvent if they acted independently.

Bedford and Electric Lighting.—At a public meeting of the Bedford ratepayers last week it was resolved that the council introduce the electric light into the borough.

Cardiff Corporation and Electric Lighting.—At a meeting of the Lighting Committee of the Cardiff Corporation, held last week, it was stated that a number of letters had been received from electrical engineers offering information on the lighting of the town with electricity, the furnishing of estimates, and showing the members over various electrical stations, and other matters pertaining to electrical lighting. It was decided to refer them to the committee appointed for that purpose.

The Lighting of Paris.—The methods in use for the lighting of houses, &c., in Paris are, according to recent statistics, as shown in the following table :—

Candles ...	...	1·6	per 100	inhabitants,	or 16	per 1,000
Vegetable oils	...	4·5	"	"	" 45	"
Petroleum	...	17·7	"	"	" 177	"
Electricity	...	18·9	"	"	" 189	"
Gas ...	...	57·3	"	"	" 573	"

It will be seen that electricity holds the second position, being far behind that of gas, however.

Action Against the City and South London Railway.—An action was brought in the City of London Court, last week, by Mrs. Lellon, to recover £50 damages for personal injuries sustained by her while travelling on the Electric Railway between the Elephant and Castle and King William Street on July 2nd. The case for the plaintiff was that the train was started while she was alighting, and she was thrown heavily to the ground. She attributed the accident to the fact of the station having been badly lighted. For the defence it was alleged that Mrs. Lellon neglected the warning of the guard to let the train stop, and that the station was well lighted. The jury awarded her £30.

Electric Lighting in Aberdeen.—At the last meeting of the Gas Committee of the Aberdeen Town Council, a report was read from Mr. Evelyn Liardet, London, in which he stated that a very large amount of power was running to waste in the waters of the Dee and Don, and that by his system he could obtain as much power from either of the rivers as would illuminate the city by electricity. His system was to put motors in the river, and to utilise the fall of the water at four different places. Reports had also been received from other sources, but the committee finally unanimously resolved to instruct the Town Clerk to write Mr. Liardet, thanking him for the trouble he had taken in the matter, but intimating that the committee did not see their way in the meantime to make any recommendation to the council upon it.

An Improvement in the Manufacture of Alkalies by Electrolysis.—In the usual methods of producing caustic soda, caustic potash, and in similar products by electrolysis, the hydrogen gas which is given off during the operation stirs up the liquid and the products of electrolysis and at the same time it covers the cathode and polarises the cell. These disadvantages are modified or eliminated by an improvement in which the cathode is covered with oxide of copper, which is reduced by the hydrogen and can afterwards be easily re-oxidised and used over again. When it is required to manufacture either caustic soda or caustic potash, the electrodes are placed in a horizontal position, the cathode being at the bottom of the cell while the anode is above it. The caustic alkali being of a heavy character, remains at the bottom whilst the chlorine produced at the anode can be led away and made use of. In using this arrangement for the manufacture of hypochlorites, the plates are reversed. When the chlorine gas is given off at the bottom and ascends through the liquid it meets with and combines with the caustic soda which is now produced above it. In small installations vertical electrodes may be used with porous diaphragms and the anode which is usually of carbon, may be replaced by one of zinc; the arrangement will then act as a voltaic cell and in effecting the decompositions, will give rise to an electric current which can be utilised.

Novel Telephone System.—A somewhat extensive and unique system of telephonic intercommunication, lately introduced by Messrs. Mix and Genest, London and Berlin, is about to be installed at the new premises in course of erection, Austin Friars, City, for the Imperial Continental Gas Company. This installation, which is the first of the kind in London, will be carried out under the supervision of Mr. McClellan, of 26, Ludgate Hill.

Chislehurst and Sidcup Lighting.—The Chislehurst Parochial Committee, last Monday week, again discussed the proposal to apply for a provisional order. Mr. R. G. Mullen (of the Electric Lighting Supply Company) said that if the local authority applied, there would be an expense of about £100 in printing, and about £50 in House of Commons expenses. The consideration of the matter was adjourned until the next monthly meeting, in order that every member might be present. An agitation has commenced at Sidcup for the electric light, and as Sidcup is a town carved out of the parishes of Chislehurst, Foots Cray, Bexley and Eltham, it comes under the same central body, the Bromley Rural Sanitary Authority, who will have to obtain the provisional order should the local committee decide in favour of so doing.

Electric Signalling in Mines.—The above subject is occupying a large amount of attention on the continent. Electrical signals are employed at Marles and Mœux (Pas-de-Calais), at Blauzy (Saône-et-Loire), while the telephone is utilised at the mines of La Perronière, in the Loire basin. It appears that the electrical system alone permits of a constant communication being given, and it is now a question of working a bell, placed in the engine room, by means of a manipulator in the cage. M. Boissau, the engineer at the Auzin mines, has adopted the very simple plan of forming the circuit with the winding cable itself, by inserting a small insulated wire therein. But it was not possible to obtain insulation for any long time, and the arrangement, besides, had the inconvenience of not allowing of repairs. M. de Pelissot, also an engineer at the Auzin mines, proposes to form a circuit by means of a metallic wire suspended freely in the shaft in the vicinity of the cage. In this system, when the cage became displaced in the shaft, the circuit is closed by pushing a bolt from inside the cage, which touches the wire. The system worked several months at an ordinary speed of 0·50 metres per second, the engineer hearing the signals clearly. At a higher speed the results were bad, on account of the imperfect contact between the brush and the metallic wire. M. Catrice, civil engineer, of Pérumelz (Belgium), has also made some experiments with an apparatus arranged on an analogous principle, and permitting of communication being preserved in case of the cage being disrailed.

Collapse of the American Rubber Syndicate.—The great American Rubber Syndicate has failed, as so many previous combinations have done, from sheer inability to go on buying the quantities necessary to maintain its control. It was unable to borrow more money to purchase the new crop now coming into Para, and the great enterprise has proved a *fiasco*. In this case, as in that of the copper syndicate, production was artificially and unduly stimulated by the height to which prices were forced, and thus the position of the combination was one of increasing difficulty. Its managers must, however, feel greatly irritated at having to suspend operations when they did, as a few weeks more would undoubtedly have placed American manufacturers much more at their mercy. Hitherto these buyers have avoided paying higher prices. When the syndicate was formed they laid in large stocks, and, as since then the rubber trade has been somewhat quiet, they have been able to get along by means of such purchases as they were able to make from importers outside the ring. No high-priced rubber had, therefore, been used, but the manufacturers could not have held off buying much longer, and must have made large purchases by now. In this connection, it may be of interest to note that the world's annual crop of rubber is about 60,000,000 lbs., of which two-thirds is used in the United States, the supply from Para being two-thirds of the whole. From there are obtained the best qualities.

Marriage.—Mr. F. J. A. Matthews, of Roper's Electrical Engineering Company, Bradford, was married at Leeds parish church yesterday week.

The School of Electrical Engineering and Submarine Telegraphy.—The manager of this school, Mr. L. Drugman, M.I.E.E., informs us that, as the result of the examination for the vellum certificate of the school, held in August, the following gentlemen have obtained the certificate in electric lighting and power transmission :—Messrs. G. Boa, J. L. Chambers, W. M. Hartin, G. Johnson, and W. B. Lock. This examination was conducted by Mr. Gisbert Kapp, M.Inst.C.E., M.Inst.E.E., and consisted of a paper in mechanical engineering, a paper in electrical engineering, a *viva vôce* and practical examination, and drawing. All these students belonged to the advanced class—instructor, Mr. Charles Capito, M.Inst.M.E., M.Inst.E.E.

The Electric Light at Bath.—At a meeting of the Bath Town Council last week, the clerk read letters from Mr. E. B. Tiltey, solicitor to the Electric Lighting Company, asking the authority to sanction the transfer of the contracts for electric lighting from Mr. Massingham to the company. The company were prepared to assume the liabilities under the contract. The Board of Trade had sanctioned the transfer of the license from Mr. Massingham to the company. The subscribed capital was £32,000. of which £29,776 was paid up. The clerk then read a clause in the contract which stated that "the said Henry George Massingham shall have power at any time during the term to assign or transfer his contract, with all its advantages or obligations to any company duly registered for the purpose of this undertaking, under the Joint Companies Act, with a subscribed capital of not less than £10,000, of which not less than £5,000 shall be paid up, and upon such assignment and the assumption by the company of the liabilities of the said Henry George Massingham under this contract at the time of such assignment and transfer the liabilities of the said Henry George Massingham and his sureties shall cease." It was contended that under the contract the council had nothing whatever to do with the transfer. It was in the power of Mr. Massingham to assign, and they wondered why Mr. Tiltey's letter was brought there. A motion to the effect that the council had no power in the matter was adopted.

Proposed Legislation on Water Power in Switzerland.—The Swiss Federal Council has now made a step towards the acquisition by the State of the water power of the country. It may be remembered that in April last the Swiss "Frei Land" Society petitioned the Federal Council on the subject. It was stated in the petition that "all yet unutilised water powers of Switzerland are the property of the Council. The winning and working of the same, as well as their conduction by electricity, compressed air, &c., are Council matters. The Council must legislate regarding the carrying out of this monopoly, as well as over the distribution of the net proceeds from the same." In a circular issued to the Cantons on the 8th inst., the Federal Council invites, to the end of the year, reports on the subject. It desires to learn to whom belong the existing water powers in the cantons, whether to the State, local authority, or private persons. What orders exist affecting their industrial utilisation ? How many water powers have already been handed over as private concessions, and how many are worked fiscally ? The Cantonal Administrations are lastly asked to express their opinions as to the leaving of the use of the water powers in the hands of private persons, or the acquisition of them by the State in the form of a Federal Council monopoly, or otherwise, and what conditions the Cantons stipulate for the renunciation of their rights to the Council, both from a legal and financial standpoint. As far as the importance of water power in Switzerland is concerned, Engineer Rob. Lauterburg, of Berne, recently published statistics of the available power. This amounts to 582,834 H.P. It is distributed mainly over the Canton Graubünden (21 per cent.), Wallis (15 per cent.), Berne (12 per cent.), Aargau (12 per cent.), Zürich (5 per cent.), Tessin (5 per cent.), and Uri (4 per cent.).

New Firm.—Messrs. McClellan & Co. have succeeded to the old established electrical engineering business of Messrs. Dale & Co., 26, Ludgate Hill, carried on for a short time by Price, Talbot and Company, Limited. Mr. S. B. McClellan has been connected with the firm for many years as chief of the technical department, and has introduced some improvements in electrical apparatus, the most important being his method of connecting and disconnecting electric circuits, particulars and drawings of which appeared in the ELECTRICAL REVIEW a few months ago. The system is working most satisfactorily at the British Museum, and at the hospital and schools at Darenth.

Roper's Electrical Engineering Company.—We hear that the business of this company has increased very rapidly since they took over the works from Messrs. Roper, the number of hands employed having doubled. Amongst other installations upon which they are at work in the north may be mentioned the Caledonian Works, Bradford (425 lights), Grosvenor Hotel, Hull (275), Chadwick's Stores, Skipton (200). T. Sill and Sons, Harrowgate (200), and Dyson's Restaurant, Manchester (150). They are about to introduce a new type of dynamo (over-type, drum, and gramme armatures), and to discard the horizontal type, their speciality being a 10 to 12 16-C.P. O.D. machine, for use with ½-H.P. gas engine.

Finsbury Technical College.—We have been asked to draw attention to a new regulation for the evening laboratory courses of instruction at the Finsbury Technical College, according to which applicants for admission to the electrical laboratory work must fill up beforehand a special form (to be obtained from the registrar), stating with what electrical firm thay are employed, or what their previous course of training in electricity has been. This regulation has been rendered necessary by the overcrowding of the laboratories in former sessions. Prof. Thompson's advanced course begins on Monday, September 28th, with lectures on electric motors and alternate current systems. The Wednesday night course begins on September 30th with magnetism, electro-magnets, and measuring instruments. Prof. Thompson's special short course on telephones is on Thursday nights, commencing October 13th.

St. Paul's Cathedral.—The redecoration of the interior of the dome of St. Paul's is now progressing, and it is a thousand pities that such high-class work is to be submitted to the ravages of the rows of gas-jets placed immediately beneath the paintings. In a few years the colours must inevitably lose their brightness, and become as gloomy as other parts of the structure where gas flames have had their way. We may instance the upper part of the pulpit in striking evidence. If the lighting of the interior of the cathedral were satisfactory, we might feel disposed to allow a little for wear and tear ; but the illumination, at any rate in the vast area beneath the dome, is anything but adequate. With all due reverence for "a dim religious light," we think the greater number of those who attend the services at St. Paul's would be willing to make a sacrifice of this questionable artistic effect for the sake of the advantage of distinct vision. The acoustic qualities of the building are such that only a small proportion of visitors can hear to understand ; and these are the fortunate few located near the choir. The vast majority have necessarily to depend upon their eyes for their devotions—some by following the service with the aid of their books, the remainder by gazing at—well, the architecture. The one is as impossible to do as the other, in the feeble light, except to those of specially strong sight. The remedy is simple. There is no public building in London so well adapted to electric lighting as St. Paul's Cathedral. The expenditure would be but slight as compared to the cost of renovation due to the present system of illumination, if we add also the advantages to be gained by the thousands who attend the services. It is possible that the innovation would be regarded as having a "theatrical tendency." Perhaps when a few more of our finest interiors have been ruined, the churches will have learnt of the theatres how to "lighten our darkness."

Electrical Disturbances.—A thunderstorm, accompanied by vivid lightning and heavy rainfall, passed over the metropolis on Tuesday afternoon. The depression for a time caused electrical disturbances over a large area.

The Liverpool City Council. — At the fortnightly meeting of the Lighting Committee of the Liverpool City Council, held on Monday last, the electric inspector, Mr. Yeaman, reported the completion of a series of tests undertaken with a view to the adoption of a standard meter with which to test the consumers 'meters in use in that city. The tests included meters of the Hookham, Hartmann and Braun, Frager, Richard Fréres, Laurence Scott & Co., Aron, and Ferranti types, which have been standardised by various methods, including Thomson balances, Fleming's method and Siemens's dynamometers. The committee approved of the adoption of the Frager meter as supplied by Mr. R. P. Wilson, London, as a standard meter within the limits mentioned in Mr. Yeaman's report, and passed an order for the purchase of the instrument at a cost of £7 10s. The report of the city engineer then submitted to the committee requested authority to appoint Mr. H. S. Hoar, of Liverpool, pupil to the electric inspector, provided his conduct was satisfactory, and that he agreed to remain not less than two years in the laboratory. The salaries of the general and junior assistants in the laboratory were raised, to date from the 1st proximo, on a report of the engineer detailing the increase in the work carried out under Mr. Yeaman, and the increase due to the commencement of the corporation pressure wire system.

Electric Lighting in Chelsea.—We extract the following from the surveyor's report which has been presented to the Chelsea Vestry :—" During the past year the electric lighting industry has been making quiet progress in the parish of Chelsea. The Chelsea Electricity Supply Company, which is the principal company in Chelsea, have added the Lowndes Square district to their area of supply, and laid their mains therein. They subsequently obtained consent to the addition of that portion of the parish east of Beaufort Street, which had not been previously included in their area of supply. Owing to the prevalence of dense fogs and other causes, this company applied to the Board of Trade to be permitted to discontinue supplying electricity during the earlier hours of the day, but this permission was not given. At the end of February last this company were lighting 215 houses. The London Electric Supply Corporation have not carried out any works in Chelsea during the past year and are still only lighting two houses. The Cadogan Electric Light Company have laid mains from Tite Street through Tedworth Square and Smith Street to King's Road in accordance with their agreement with the vestry. The company has been re-formed under the title of the New Cadogan and Belgrave Electric Supply Company, and at the time of the re-formation they suggested to the vestry that their agreement as to laying mains should be transferred to the new company. The vestry, however, suggested that the company should apply for a provisional order in the usual manner. This was done, and at the end of the financial year the suggested order was under discussion. At the end of February the company were lighting 16 houses in Chelsea. The number of houses lighted by electricity in Chelsea was :—

	1889-90.		1890-91.
Chelsea Electricity Supply Company	113	...	215
Cadogan Electric Light Company ...	25*	...	16
London Electric Supply Corporation	1	...	2
	139		233

It is thus seen that there have been about 100 houses which have adopted electric light during last year. In May, 1890, the Board of Trade forwarded a draft of regulations which it was proposed to serve upon the London Electric Supply Company. Two slight alterations which I suggested were approved by the vestry, submitted to the Board of Trade, and subsequently adopted by them and included in the regulations. During the year, I submitted a somewhat lengthy report on the subject of overhead wires, underground pipes, mains, &c., and also submitted plans showing (as far as possible) the positions of all such pipes, wires, mains, &c."

* This probably included some houses in the Belgravian district.

Personal.—Mr. W. J. Tickner, who has represented Messrs. W. Höfler & Co., of 45, Jewin Street, E.C., for the past three years, will at the beginning of October, act as representative for Taylor and Tucker, Art Metal Company, Limited.

The Electric Light in Chicago.—One of the largest private electric light plants is that to be erected in the Masonic Hall, Chicago. The plant will include six 80,000 watt generators, giving current to nearly 8,000 lights.

Electricity in Philadelphia.—At the end of last year there was a total of 5,497 miles of wires connected to poles, fixtures, and buildings, of which 4,314 miles were telegraph and telephone wires, and 425 miles electric light wires.

Damage to Telephone Wires in Bermuda.—A Bermuda telegram to *The Times* on 21st inst., states that a storm had been raging there since Sunday morning. Telephone and telegraph wires and trees have been greatly damaged.

The Mauritius Cable.—A *Times* correspondent says : " A cable having been projected by the colony at Mauritius to pass through one of the Diego Suarez Islands, Tamatave and Réunion, the English Governor has refused his permission under the pretext that, in case of war, Mauritius would be at the mercy of France for its news, and has insisted upon the line going by way of Mahé and Zanzibar.

Electric Welding in Australia.—At the beginning of last month Messrs. H. H. Kingsbury & Co., electricians, Sydney, gave engineers in New South Wales an opportunity of witnessing the first application in Australia of electricity to the welding of metals, a small example of the plant made by the Thomson Electric Welding Company, of Lynn, Mass., U.S.A., having been fitted up by them in the Sydney Town Hall for the purpose.

City Commissioners and Electric Lighting Companies.—At the first meeting of the City Commission of Sewers since the recess, held at Guildhall on Tuesday last, the chairman, Mr. Sheppard Scott, reported that, during the recess, he and the solicitor had, at the request of the Board of Trade, satisfied themselves as to the due constitution and the adequate subscription of the capital of the City of London Electric Lighting Company, and they saw no objection to the proposed transfer of the contracts from the Brush and other companies to that company. The commission approved their decision.

The Crystal Palace and District Electric Lighting —Messrs. J. E. H. Gordon & Co., of 11, Pall Mall, who have secured the order for the central station and mains for the supply of electricity to the Crystal Palace Exhibition, and afterwards to the Sydenham district, are making rapid progress with their works, and they will have their station of 20,000 lights capacity in full work on the opening of the exhibition, on January 1st next. It will be remembered that the prospectus of the company, which holds the provisional order for the district, was issued about a month ago.

Amalgamated Dairies Company, Limited, v. Electricity Supply Corporation, Limited.—This was an application which came in the High Court of Justice before Mr. Justice Jeune, for an injunction to restrain the defendants from continuing to cause a nuisance by driving certain machines. It was stated that the defendants had lately been largely increasing their business and putting up new machinery, and the plaintiff produced affidavits from 11 different people, who stated that the working of the defendants' machinery made it impossible for them to get a good night's rest, the vibration causing their beds and windows to shake. The Court ordered the motion to stand over the vacation. Sir A. Watson, Q.C., and Mr. Pochin for the plaintiffs ; Mr. Marten, Q.C., and Mr. Terrell for defendants.

Woodhouse & Rawson United, Limited.—Messrs. Woodhouse & Rawson have opened a branch office at 89, Bothwell Street, Glasgow, under the management of Mr. B. F. Howard, who has been appointed their agent for Scotland.

The Cost of Electric Power.—Freiburg, in Switzerland, possesses the cheapest supply of electric power, the cost being about 1½d. per horse-power per hour. The cost in Paris amounts to about 9d. per horse-power per hour.

Nelson Corporation and the Electric Light.—We hear that the Nelson Corporation Gas Department have canvassed a few of the principal streets of the Borough, and have got guarantors to take 400 lights. The Corporation will put down a plant for 600 lights.

The Victorian Electrical and Telegraphic Journal, —We regret to notice that this journal, after an existence of five years, has come to an untimely end through lack of support. During its life the paper did much good work, and very useful matter was to be found in its pages.

Lightning Conductors for Municipal Buildings, Bombay, India.—Mr. Jos. Blackburn, of Nottingham, has been awarded the contract for the whole of the lightning conductors for the new Municipal Buildings, Bombay, India, and they are now being specially made by him and will be fixed on his registered system.

Cardiff Electric Lighting.—We are informed by W. Farrar, the London agent for Wilson Hartnell, Leeds, that he has secured the order for the electric lighting of the new Flour Mills owned by Messrs. James Tucker, Limited, Cardiff. When complete, these premises will rank amongst the largest in the country.

The French Association for the Advancement of Science.—The 20th session of this association was opened at Marseilles on the 17th inst, M. P. P. Dehérain being the president. A large number of papers were read, and numerous visits were made to scientific and industrial works in the district.

The Dynamite Gun.—In an article on "The Development of the Dynamite Gun" in the *Engineering Magazine* (American) we find it stated that the type of gun finally adopted for sea coast defence was designed by Captain John Rapieff, formerly an officer in the Russian Army. Captain Rapieff, some few years ago, was well known as the inventor of a system of electric lighting which was in use, amongst other places, at the *Times* offices.

The Consulting Engineering Profession.—Particulars are to hand from the States of a new departure, which has recently been made by a firm of electrical engineers in New York, *i.e.*, Messrs. W. Ward, Leonard & Co. For an annual sum of £10, this firm undertake to answer all questions from the manager of a central station plant, regarding the management, both electrical, mechanical, and financial, of the station of which he has charge. For half the above annual sum (£5) they undertake to answer all questions from the superintendent of a private electric lighting plant, regarding new apparatus, improvements, &c.

Note for Investors.—The *Daily Oracle* states:—"Investors who want to make money this autumn, will probably turn their attention to Anglo-American Telegraph Ordinary and Preference. If these stocks are not to rise, it would be hard to point to others that are more likely to do so. New York is already alive to the business which America's big harvest will certainly bring to the cable companies, and within the past few days commercial cable stock has been lifted visibly. We on this side, however, appear to have paid very little regard to the splendid good fortune which is now befalling these concerns, but in the small rise already secured by "Anglo-Americans" and "Direct U.S.," we probably have demonstration of the fact that a few "insiders" are quietly accumulating stock."

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cuttriss, Wallis and Company, Limited (Electrical Engineers).—The statutory return of this company, made up to the 14th ult., was filed on the following day. The nominal capital is £10,000, in £5 shares. 736 shares have been taken up, upon 316 of which £3 per share has been called. The calls paid amount to £938 and unpaid to £10, while 420 shares are considered as fully paid. Office, Elmwood Electrical Works, Camp Road, Leeds.

J. Cawthra and Company, Limited.—The statutory return of this company, made up to July 7th, was filed on July 13th, 1891. The nominal capital is £120,000, in £10 shares. All the shares have been taken up, and the full amount called and paid on 12,745, while the full amount has been considered as paid on the remainder. Office, 7, Swaine Street, Bradford.

Collier Audible Telephone Syndicate, Limited.—The statutory return of this company, made up to the 1st inst., was filed on the 7th inst. The nominal capital is £9,000, in £100 shares, all of which have been taken up, the full amount called, and £2,860 paid, leaving £140 unpaid; 60 shares are considered as fully paid. Office, 5A, Coleman Street, E.C.

Froude Hurrell Torpedo Company, Limited.—The statutory return of this company, made up to the 14th ult., was filed on the 21st ult. The nominal capital is £10,000, in £10 shares, of which 121 are taken up, the full amount called, £760 paid, and £450 unpaid. Office, 3, Broad Street Buildings, E.C.

Weybridge Electric Supply Company, Limited.—The statutory return of this company, made up to the 8th ult., was filed on the 3rd inst. The nominal capital is £15,000 in £5 shares; seven shares have been taken up, but no calls have been made. No agreement has as yet been filed. Office, Thames Street, Weybridge.

CITY NOTES.

South Staffordshire Tramways Company.—A meeting of the directors and shareholders of this company was held on 17th inst. at Darlaston, when it was resolved to adopt the overhead system of electric tramcars instead of the present steam traction, for the towns of Walsall, Wednesbury, and Darlaston. It was also decided to authorise the creation and issue of £50,000 worth of debentures, bearing interest at 5 per cent., to carry out the system, which will be the first of its kind adopted in the United Kingdom. It was explained that the electric traction would save at least 3d. per mile upon the present cost of working by steam. The local authorities have given their unanimous consent, and the contract will be commenced at once.

W. T. Henley's Telegraph Works Company, Limited. —Messrs. W. T. Henley's Telegraph Works Company are issuing, by special resolution, £30,000 of preference share capital, in 3,000 shares of £10 each. This has been rendered necessary owing to increase in business, the works having to be enlarged and improvements made to the machinery. This preference capital will be entitled to a cumulative preference dividend of 7 per cent. per annum, and to pay such dividend will take £2,100. The average profits of the company for the last three years have exceeded £16,000 a year. Nearly half the £30,000 has been already subscribed by the directors and friends, and subscriptions are invited for the remainder of the shares.

Eastern Extension, Australasian and China Telegraph Company, Limited.—The Eastern Extension, Australasian and China Telegraph Company notify that the directors have declared an interim dividend for the quarter ended 30th June last of 2s. 6d. per share, free of income-tax, payable on the 15th of next month.

The City of London Electric Lighting (Pioneer) Company.—The transfer books and register of members of the City of London Electric Lighting (Pioneer) Company have now been finally closed.

Globe Telegraph and Trust Company, Limited.—The directors have declared an interim dividend of 3s. on the preference and 2s. on the ordinary shares.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended September 18th, amounted to £4,849.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 18th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company were £3,780.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Sept. 17th, 1891.)	Closing Quotation. (Sept. 24th.)	Business done during week ending (Sept. 24th, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	100⅛	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	49 — 50	48 — 49	49½	48½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½— 88½	86½— 87½	88	86⅝
2,849,510*l*	Do. do. Deferred	Stock	14 — 14½	13⅞— 14	14½	13⅞
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜— 12⅛	11⅜— 12⅛	12⅛	11⅝
53,200*l*	Do. do. 5 p. c. Bonds	100	99 —102	99 —102	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3½— 3⅝	3½— 3⅝	3⅝	3½
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2⅛	1⅞— 2⅛	2⅛	1⅞
50,000	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	2 — 4	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	117 —120	122 —124	122½	120⅝
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5⅛	5 — 5⅛	...	...
16,000	Cuba Telegraph, Limited	10	10 — 11	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 4	3¼— 4	...	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅞— 11⅛	10⅞— 11⅛	11⅛	10⅞
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14¼— 14½	14⅛— 14⅜	14½	14⅛
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15⅜	15 3/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	108¼	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	14⅞— 15⅛	15¼	14⅞
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	106 —109	107½	107
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	99½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4⅜— 5¼	6 — 6¼	6¼	6
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3⅜— 3⅝	3 — 3⅛	3⅛	2 15/16
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	4⅛— 4⅜	3⅞— 4⅛	4⅛	3⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	2⅛— 2⅜	2⅛— 2⅛	2⅛	2⅛
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9⅞	9⅝— 9⅞	9 13/16	9 11/16
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15⅛	15 1/16	14 13/16
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19¼	18¾— 19¼	19 1/16	19
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11	10 — 11	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	20 — 21	20 — 21	20⅜	20 1/16
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ...	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9⅝	9¼— 9⅝	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	104 —107	105 —108	106¼	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	10 — 10½	10 — 10½	10 7/16	10 1/16
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4½— 4⅝	4⅜— 4⅝	4⅝	4 7/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13½	12½— 13	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13	12½— 13	12½	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	106 —108	106 —107	107½	106½
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	3½— 4½	3½— 4½	4⅛	4
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000*l*	Reuter's Limited	8	8 — 8½	8 — 8½	8⅜	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8 — 8½	7¾— 8¼	8 3/16	7 15/16
7,900	Do. do. do. 7 per cent. pref.	2	4½— 5	4¾— 5¼	5 1/16	4 13/16
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	5¼— 5	5 — 5½	5⅜	5 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43⅛	43
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	8	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	96 — 99	96 — 99	98	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4	3¾— 4¼	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —102	98 — 103	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10¾— 11¼	10¾— 11¼	11⅛	10¾
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	7	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4½— 5	4⅝	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 —105	102 —105	104¼	103½
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 —105	102 —105	104½	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 2	1⅝— 1⅞	1⅝	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¾— 10¼	9½— 10	9¾	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜— 6¼	5⅜—6¼	6⅛	5⅜

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅝.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 60—62.—Ordinary of £10 each, £4 paid, 4—4½.—Elmore's Austrian Copper Depositing, 15s., 25s., £2 share issued at 10s. prem., fully paid, 1—1¼.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid) 4½—5.—Liverpool Electric Supply, £3 paid, 2⅝—2¾.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅝—1¾.—Manchester, Edison and Swan Company, £9 (£1 paid) ¼ — ⅓.—National Telephone Debentures, 2½ — 3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2⅛—2⅜.—£5 Preference, fully paid 3¾—4.—Debentures 90—95.—Wards Electric Car, £10 paid, ⅝—1.

BANK RATE OF DISCOUNT.—3 per cent. (September 24th, 1891).

THE FLORENCE AND FIESOLE ELECTRIC RAILWAY.*

BY CHARLES PRELLER SHEIBNER, Ph.D., Assoc. M. Inst. C.E.

THE town of Fiesole is situated at an altitude of 292 metres above sea-level, or nearly 800 feet above Florence, of which it is now practically a suburb, the aggregate population of the two being upwards of two hundred thousand inhabitants, irrespective of the annual influx of visitors estimated at sixty thousand. The large residential and tourist traffic between the two places has, within the last few years, led to several proposals for carrying a railway up the steep slope to the centre of Fiesole at the summit of the hill; but the local authorities having rejected steam-traction either by rack or by ordinary adhesion engines as being, in this special case, and for obvious reasons, at once inadequate and obnoxious; and a wire rope or cable railway being impracticable on other grounds, it was not till the year 1889 that the use of electric motive power with overhead wires was resolved upon and authorised. The line, which measures 7·3 kilometres (4·5 miles) between terminal points, and has gradients up to 8 per cent., is the first continuous steep-grade electric railway in Europe. The system adopted is an improved form of that of Sprague, which had already been applied at Richmond, U.S., and which differs essentially—more especially as regards the mode of transmitting the current from the contact wire to the motors—from the systems used on other and more or less level electric lines, such as those of Berlin, Frankfort, Vienna, Pesth, Montreux, or the City and South London. The Florence and Fiesole line was constructed, and is owned and worked by the Chianti and Florentine Hills Railway Company, of Florence; it was opened for traffic under a provisional order in September, 1890; but in consequence of an accident which occurred on the 29th of that month, and in which, out of thirty passengers, five lost their lives, the service on the steep-grade section was, by order of the Government authorities, suspended pending an inquiry. This inquiry having conclusively shown that the accident was in no way due to any defect in the permanent way, electric plant, rolling stock or brake power, but solely to the negligence of a brakesman, the line was reopened throughout in the month of April, 1891, and has ever since worked with perfect safety and regularity.

THE LINE.

Starting in Florence from the Piazza San Marco, whence it is shortly to be extended to the still more central Piazza del Duomo, the railway, which is a single line on the 4 feet 8½ inches gauge, is laid alongside the public road, except between kilometres 1·4 and 4·7, a length of about 2 miles, where it occupies the centre and virtually monopolises the whole of the roadway, the vehicular traffic taking the old and shorter road. With the exception of a short paved section in Florence, where the permanent way consists of heavy Phœnix girder rails, the line is laid throughout with steel rails of special Vignoles section, weighing 24 kilogrammes per metre (48 lbs. per yard), 9 metres in length, fastened to ten oak sleepers (2·60 × 0·18 × 0·13 metres) per rail length, which, with the steel angle fish-plates, bolts of 20 millimetres diameter, sole plates, and stout spikes at the suspended joints, make a substantial permanent way admirably suited for a light steep-grade railway with sharp curves and constant traffic. The rails and fastenings were supplied from the Steel Works of Messrs. Tardy and Benech, of Savona, and the cost of permanent way did not exceed 18 lire per metre lineal (13s. 2d. per lineal yard). The depth of the rail being 10·5 centimetres, its moment of resistance is $0{\cdot}07 \times 10{\cdot}5^3 = 81$ centimetres, and the distance between centres of bearings being 94 centimetres, it can bear a maximum load of $\frac{8 \times 1{,}000 \times 8{\cdot}1}{94} = 6{\cdot}9$ tons, whereas the greatest load per wheel does not exceed 2 tons. Of the total length of the line (4½ miles) no less than 52 per cent. is in curves, the sharpest of which, down to 18 metres (59 feet) radius, occur chiefly on the steep-grade section. Guard rails are used only at the inside rail and in curves sharper than 80 metres (262 feet) radius, the greatest super-elevation of the outer rail being 10 centimetres (3·9 inches), and the gauge being widened 1 centimetre (0·4) inch. At kilometre 6, about halfway up the steep-grade section, a reversing station, 50 metres in length, was put in to avoid too sharp a curve, and at the next curve (kilometre 6·1) a safety siding, 34 metres in length, with an incline of 34 per cent., has lately been constructed. Between Florence and Fiesole, six intermediate stations with sidings and passing places are provided, the points and crossings being automatic. The company, besides keeping its own line in repair, pays to the local authorities an annual easement of 600 lire per kilometre (£38 per mile), of paved section, and of 300 lire per kilometre (£19 per mile) of open road occupied. At kilometre 1·3, the line crosses on the level both the Rome, Florence, and Bologna, and the new Apennine, Florence and Faenza Railways (Adriatic system), figs. 1 and 2, the former at right angles, and the latter at an angle of 76°. The multiplicity of these level crossings in Italy is a peculiar feature arising out of the remarkable growth of light local railways laid alongside public highways, and virtually or actually separated from the ordinary traffic; nor can the trunk railways, with which many of the local lines vigorously compete, prevent such crossings on a road owned by the local authorities or by the State. On both the Adriatic and Mediterranean systems, these level crossings are formed by a solid framework of longitudinal and transversal bearings to which iron plates are screwed parallel and contiguous to the rails of the light railway crossing the trunk line. On the Adriatic system, the standard section of 36 kilogrammes per metre (72 lbs. per yard) is used for rails and guard rails on both the trunk and local line, the rails on the latter being raised and cut at the points of intersection, so that the flanges of the wheels of the local line rolling stock pass over the main line rails. On the Mediterranean Company's system, on the other hand, the practice is to cut the main line rails (by forming a small groove of 5 centimetres in the head of the rail for the passage of the wheel flange), at the points of intersection in crossing at angles between 90° and 75°, and not to cut them in crossings between 75° and 45°, figs. 3 and 4. On the light line, the rails used at crossings are of a special grooved section with parallel and contiguous iron plates, or the whole crossing is formed of one solid piece. Both lines are protected by gates and signals worked by the signalman of the main line, the nearest stations on both sides of which are connected with the crossing by electric bell or by telegraph. The average cost of a level crossing, including gates and signals, is about £500; the amount paid for the easement to the main line company, including cost of lighting and working the signals, being only about £40 per annum, whereas the annual interest on the cost of a bridge with approaches would be three or four times that amount.

ELECTRIC MOTIVE POWER.

For the purpose of ascertaining the requisite motive power, the line may be conveniently divided into three sections, fig. 5, viz.:—

	Kilometres.	Service.	Speed per hour.
1st. Flat section	2·6	20 minutes	14 kilometres.
2nd. Five per cent. gradient	2·1	20 „	10 „
3rd. Eight per cent. „	2·6	40 „	8 „

The speed being, therefore, 3·88, 2·77, and 2·22 metres per second respectively, the total weight of a car when full being 7·5 tons, and the resistance in sharp curves being taken at 10 kilogrammes per ton,* the work performed on the different gradients is as follows:—

	Kilogrammetres.
1st section up car $7{\cdot}5 \times (0 + 10) \times 3{\cdot}88$	= 291
„ „ down car $7{\cdot}5 \times (0 + 10) \times 3{\cdot}88$ ...	= 291
2nd „ up car $7{\cdot}5 \times (50\frac{0}{00} + 10) \times 2{\cdot}77$ ...	= 1,247
„ „ down car descending by its own weight	= ...
3rd „ up car $7{\cdot}5 \times (80\frac{0}{00} + 10) \times 2{\cdot}22$ ...	= 1,498
„ „ down car descending by its own weight	= ...
Total	3,327

Assuming, therefore, that there is one car running simultaneously in each direction and on each section, the effective motive power required is $\frac{3{,}327}{75} = 44$ H.P.,† which at the guaranteed minimum efficiency of 60 per cent., is equal to 73 H.P., to be supplied by the central station.

The electric works are situated at S. Gervasio at the end of the flat section, 2·6 kilometres from the Florence terminus and 4·7 kilometres from that at Fiesole. Three return-flue boilers, supplied by Messrs. Tosi, of Legnano, near Milan, of 80 H.P. each, inside diameter 1 metre, outside 2 metres, feed three compound engines with vertical cylinders, of 80 H.P. each, made by the Oerlikon Works of Zurich (Hoffman's patent), and working at 225 revolutions per minute; and these drive three Edison compound dynamos (No. 20), which, at 900 revolutions per minute, give 110 ampères at 500 volts, each dynamo developing 75 effective H.P. or 93 per cent. of the engine power. One dynamo, therefore, is sufficient for the ordinary winter service, as stated above, as well as for lighting the cars and the works, while on feast and holidays, and in the summer season, when the service is increased, the requisite power is supplied by two dynamos, one engine and one dynamo being always kept in reserve. The consumption of Cardiff coal is about 900 kilogrammes per engine per day, the pressure in the boiler being 140 lbs. per square inch. The feed-water, which is heated up to 80° Centigrade (176° Fahrenheit) before passing into the boiler, is derived by steam pump from the conduit of the Florence Corporation Waterworks.

CONDUCTORS.

The circuit is arranged as follows:—An overhead main conductor consisting of a covered copper wire (No. 3 B.W.G.) is carried on poles placed at a distance of from 6½ to 13 feet from the centre of the line, and 40 metres (130 feet) apart in straight sections, and 25 to 30 metres (80 to 100 feet) in curves. They are 9 metres (30 feet) high, and are let 2 metres (6½ feet) into the ground. They consist of ornamental cast iron columns with brackets in the Florence (town) section, the insulators being fixed to the top (fig. 6), whilst in the open and up to Fiesole timber poles are used. The contact wire, which is of silicon bronze and 5 millimetres (⅕th inch) in diameter (No. 4 B.W.G.), is suspended over the centre of the line 6 metres (20 feet) above the rails, from the brackets of the iron columns or poles, in those places where

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* Some interesting experiments to ascertain the resistance in sharp curves were made in 1890 on the Mödling (Vienna) Electric Railway by means of a dynamometer placed between the two cars composing the train. The permanent way of this line consists partly of grooved, and partly of Vignoles rails. On a 1·5 per cent. gradient with curves of 30 metres radius, and at a speed of 15 kilometres per hour, the resistance (irrespective, of course, of that due to the gradient), was found to be 8 to 10 kilogrammes per ton of train-weight on the Vignoles section, and 12 kilogrammes on the grooved section.

† On the metric system.

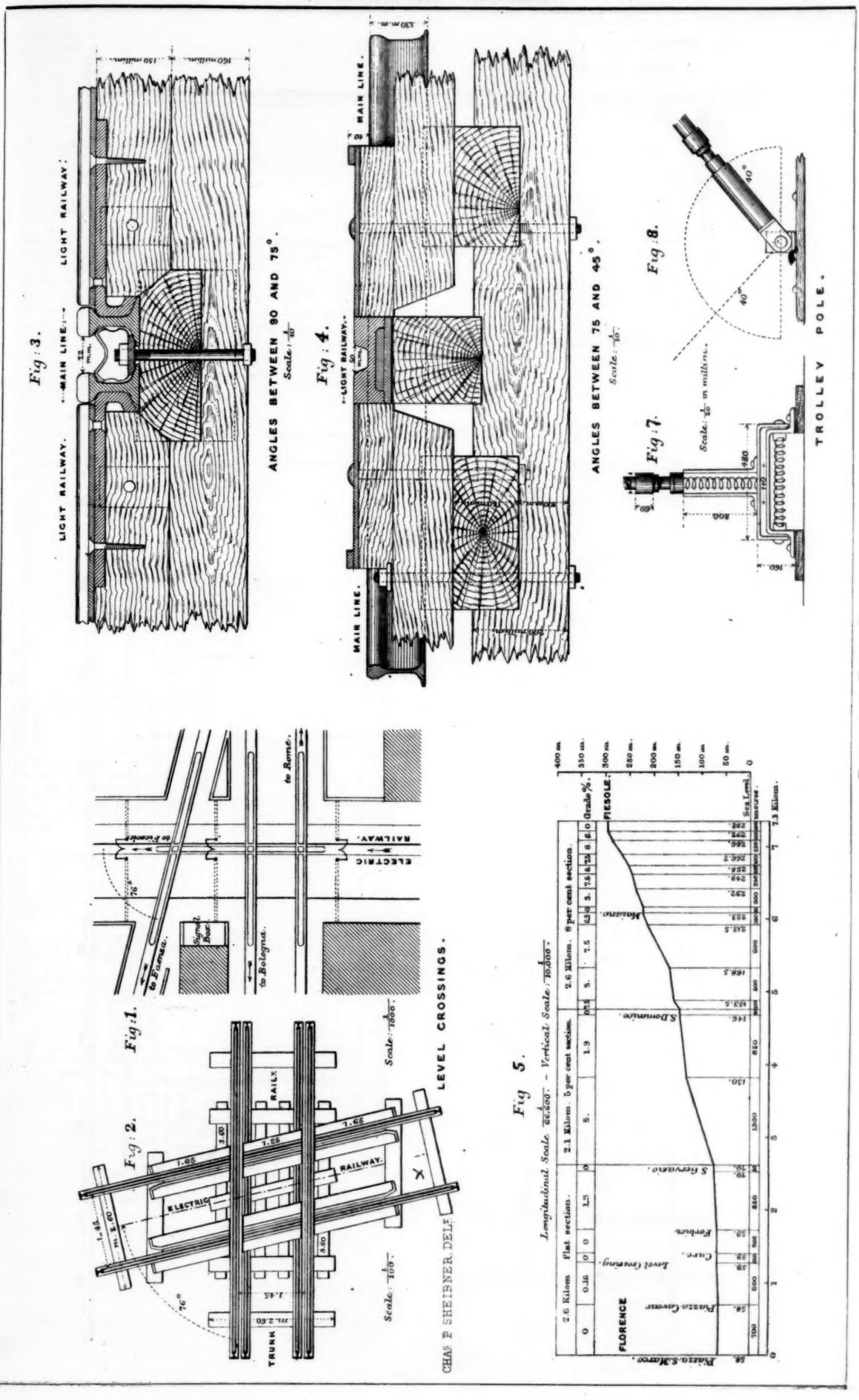
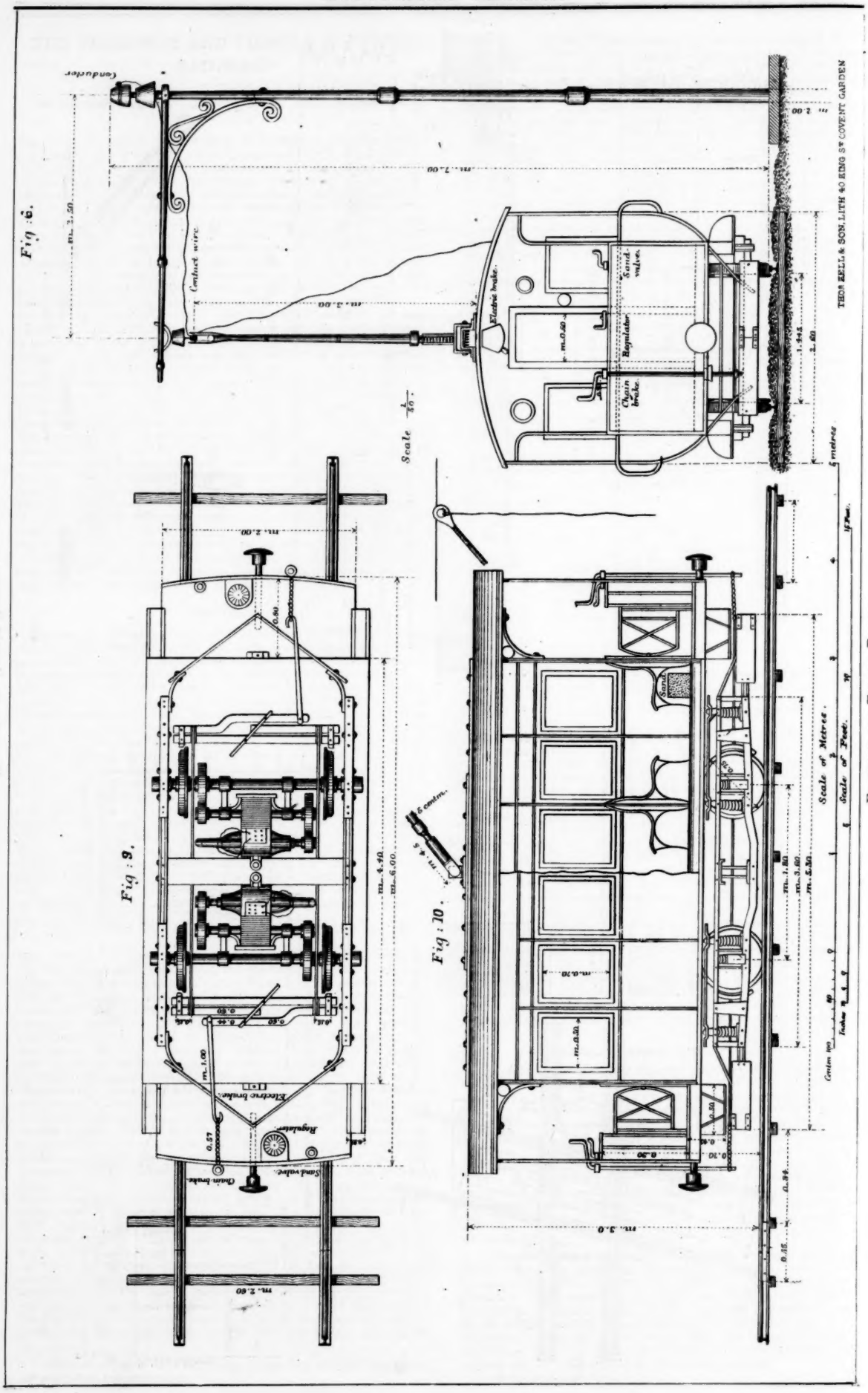


Fig. 3.
LIGHT RAILWAY.
MAIN LINE.
LIGHT RAILWAY.
ANGLES BETWEEN 90 AND 75°.
Scale: 1/10
Fig. 4.
MAIN LINE.
LIGHT RAILWAY.
MAIN LINE.
ANGLES BETWEEN 75 AND 45°.
Scale: 1/10
Fig. 8.
Fig. 7.
Scale: 1/5 in millim.
TROLLEY POLE.
Fig. 1.
to Rome.
to Florence.
to Bologna.
RAILWAY.
ELECTRIC
Scale: 1/1000
Fig. 2.
RAILWAY.
ELECTRIC
TRUNK
Scale: 1/100
LEVEL CROSSINGS.
CHAS P SHEIBNER. DELT.
Fig. 5.
Longitudinal Scale 1/5000. - Vertical Scale 1/1000
FLORENCE
FIESOLE
Piazza S. Marco
Piazza Cavour
Level Crossing
Cure
Fortezza
S. Ferreolo
S. Domenico
Mainano
Sea Level
7.3 Kilom.
FLORENCE AND FIESOLE RAILWAY.



FLORENCE AND FIESOLE RAILWAY.

the line runs alongside the road, and from transverse wires hung from poles on both sides of the road, where the line is situated in the centre of the roadway, while in curves the contact wire is kept in position by diagonal wires as well. The main conductor, which has a resistance of 0·8 ohm per kilometre,* transmits the current to the contact wire in sections of about 40 metres (130 feet), there being, moreover, between S. Gervasio and Fiesole two subsidiary conductors, which are connected with the main conductor. From the overhead wires the current passes through the trolley and motors of the car to the rails which form the return circuit. No earth plates are used; but to ensure perfect continuity of the circuit, the rails are connected at the joints by a copper wire fixed to small iron pins, which pass through the flange of the rail.

Trolley and Motors.

The small trolley wheel, 5 centimetres (2 inches) in diameter, which runs along the lower surface of the contact wire, is carried on a tubular pole 4·5 metres (15 feet) high and 5 centimetres (2 inches) in mean diameter. This trolley pole, which has a lateral play of 90 centimetres (3 feet) and a vertical play of 3 metres (10 feet), is reversible, its lower end being fitted to a ⊓ shaped iron, which is riveted to the centre of the roof of the car (figs. 7 and 8). When the train is in motion, the trolley pole is inclined in the direction opposite to that in which the car is running (fig. 10) at an angle of about 40°, so that it projects beyond the back platform, and by means of a loose cord suspended from it is brought under the control of the guard.

Each car carries two motors (fig. 9), whose armatures consist of 28 spirals of 0·64 ohm resistance each, the maximum efficiency being 90 per cent. less 25 per cent. due to loss by gearing. They are suspended between the car axles and a transversal iron riveted to the car frame. The motion is transmitted to the car wheels by toothed gearing, the smaller wheels of each pair being of bronze, in view of the greater tensile strain on steep grades. The ratio of gearing is as 1 to 12, and the dimensions are as follows (in millimetres):—

Pinion.	Dimensions of teeth.			Diameter at pitch circle.
	Depth.	Width.	Length.	
No. 1	10	7·5	95	100
„ 2	10	7·5	95	400
„ 3	15	10·0	100	140
„ 4	15	10·0	100	420

The motors, which are of the Sprague type, have three conductors which, by means of the regulator on the platform, can be coupled in seven different ways, the speed being increased according as the arrow on the disc of the regulator is moved from the central or "off" position to the left, the seventh point on the disc marking the maximum tractive effort. In the same way, the motion can be reversed by moving the arrow of the regulator from the "off" mark to the right. The motors are tested to develop up to 20 H.P. each, or 40 H.P. for both, which, at 736 volt-ampères per H.P. and a potential of 500 volts, is equal to 60 ampères derived from the main conductor, and represents 40 × 75 = 3,000 metre kilogrammes, less 25 per cent. for friction by gearing, or 2,250 metre-kilogrammes, equal to $\frac{2,250}{75} = 30$ effective H.P. As has already been shown, the effective motive power required per car on the three sections at the regulation speeds of 14, 10, and 8 kilometres per hour is only 4, 16, and 20 H.P. respectively; whereas working at full power, the maximum attainable speed would be:

$$\text{on the flat section} = \frac{2,250}{7·5 \times (0 + 10)} = \begin{cases} 30 \text{ metres per second} \\ (67 \text{ miles per hour}) \end{cases}$$

$$\left.\begin{matrix}\text{on the 5 per cent.} \\ \text{gradient}\end{matrix}\right\} = \frac{2,250}{7·5 \times (50 + 10)} = \begin{cases} 5 \text{ metres per second} \\ (11 \text{ miles per hour}) \end{cases}$$

$$\left.\begin{matrix}\text{on the 8 per cent.} \\ \text{gradient}\end{matrix}\right\} = \frac{2,250}{7·5 \times (80 + 10)} = \begin{cases} 3·33 \text{ metres per second} \\ (7\tfrac{1}{2} \text{ miles per hour}). \end{cases}$$

On the flat section the maximum speed would, on a line of this class, be of course inadmissible in practice: the car could, however, besides its own weight, take a train of four ordinary carriages at $\frac{2,250}{5 \times 7·5 \times (0 + 10)} = 6$ metres per second = 13 miles per hour, while it could haul one carriage weighing 7·5 tons at the rate of 6 miles per hour on the 5 per cent. gradient, and 4 miles per hour on the 8 per cent. gradient.

The pinions are now being encased in metallic boxes, which has the double advantage of deadening the noise, which, however is not great, and of protecting them from dust. The motors are placed immediately under the floor of the car, where they are easily accessible for inspection by four covered openings in the central passage.

Cars.

The car, fig. 10, seats twenty-four passengers, and has a length of 4·4 metres (14·4 feet) or 6 metres (20 feet) including the platforms, the rigid wheel-base being 1·8 metre (6 feet). The overhang would appear excessive, were it not for the fact that the car, instead of being directly fitted to the frame, rests on four separate longitudinal bearings, each supported by two spiral springs 1·9 metre (6 feet) apart, one of which is placed at the extremity of the car-frame, while the latter itself is supported by four spiral springs carried by the axles, so that the car rests on a basis twice that of the frame. Moreover, of the total weight of the car when empty (5 tons), no less than half, represented by the car-frame, wheels, and motors, is placed below the floor, so that when the car is full (7·5 tons) its centre of gravity is only 1 metre above the centre of the rails. Not only is the short wheel-base, therefore, fully compensated by the special mode of suspension, but the car combines elasticity of motion with a maximum of stability.

Curves of 14, and even 12 metres radius can be passed with perfect safety, the more so as the width of the wheels, including the flange, is 9 centimetres, and that of the rail-head 5 centimetres, while the space between the rail and the guard rail in sharp curves is widened to 5·5 centimetres. The car is lighted with five incandescent lamps inside. Each platform is fitted with a regulator disc, a sand-valve handle, a mechanical chain-brake, and an electric safety brake, all four being within easy reach of the driver, while the guard on the back platform has to watch the trolley, the two platforms being in communication by electric bells. The outside width of the car is 2·6 metres (8½ feet), and the total height above the rails is 3 metres (10 feet), the centre of the roof being 3 metres below the contact-wire. The electric plant, including car-frames and motors, was supplied by the Edison General Electric Company, of New York, and mounted by Mr. Sprague's agent; while the cars, which can be easily removed from the frames, were built at the Desireau Works of Florence.

Brake Power.

The brakes are three in number, and are independent of each other. The first reverses the motors by moving the arrow of the regulator from the "off" point to the right in the manner already described. The ordinary current derived from the conductor being 60 ampères or 2,250 kilogrammetres equal to a tractive force or effective break power of $\frac{2,250}{2·22 \text{ metres per second}} = 1,013$ kilogrammes, and the component of gravity of the car down the 8 per cent. gradient being only 600 kilogrammes, it follows that by this simple means the car could be almost instantaneously arrested even if it ran down the incline at a much higher speed than that prescribed. The second brake, of recent application, is worked by a handle fixed over the door, and utilises the power generated in the motors themselves when rotating, and therefore acting as dynamos. This brake, being independent of the current *per se*, is obviously the more economical of the two. Both of these, however, are only to be used in case of danger. The third and ordinary brake, which can be worked from either platform separately, or from both platforms jointly, is a powerful mechanical chain brake acting by means of a system of stout lever plates on all four wheels simultaneously, the ratio of increase of the pressure exerted at the handle of 30 centimetres (12 inches) radius, being 1 in 136. The brake power, determined by the proportionate lengths of the lever arms, and varying according to the energy exerted by the brakesman, works out as follows:—

$$P = 2 (p \times 8 \times 8) + p\,8.$$

p = pressure exerted at handle.		P = power.	Effective brake power.	
			At ¼th adhesion.	At $\frac{1}{10}$th adhesion
Kilogram.		Kilogrammes.	Kilogrammes.	Kilogrammes.
20	44 lbs.	2,720	453	272
25	55 „	3,400	566	340
30	66 „	4,080	680	408
40	88 „	5,440	930	544
50	110 „	6,800	1,133	680

The momentum of a car running down the 8 per cent. incline at 8 kilometres per hour is 2,958 metre-kilograms. Applying therefore a brake pressure of only 20 kilograms, the car will stop within 7 metres and 6 seconds if the rails are dry (¼th adhesion); while even under unfavourable conditions ($\frac{1}{10}$th adhesion), the same minimum pressure is sufficient to stop the car within 11 metres (about two car lengths) and 10 seconds. And even if the car were to acquire a speed of 20 kilometres per hour, the maximum pressure of 50 kilograms at only $\frac{1}{10}$th adhesion could stop it within 27 metres and 9 seconds. Again, with the same maximum pressure, on the level, and at a speed of 14 kilometres per hour and ¼th adhesion the car will stop within 5 metres and 3 seconds. The following Table gives the calculations by which these figures are obtained:—

* Diameter 5 millimetres; hence sectional area = $\frac{3·14 \times 5^2}{4} = 20$ millimetres square; hence resistance per kilometre (1,000 metres), the coefficient for copper being 0·017, = $\frac{1,000 \times 0·017}{20} = 0·8$ ohm. This corresponds to a current of 64 ampères at 500 volts, the mechanical work being = $\frac{64 \times 500}{9·81} = 3,262$ metre-kilogrammes; hence the resistance = $\frac{3,262}{64 \times 64} = 0·8$ ohm, and the effective H.P. = $\frac{3,262}{75} = 44$ H.P.

Speed per hour in kilometres.	Momentum in Metre-kilograms.	Ratio of adhesion.	Stopping distance in metres.	Ratio of retardation in metres per second.	Time in seconds.
8	$7{\cdot}5 \times 80 \times 2{\cdot}22^2 = 2{,}958$	$\frac{1}{6}$	$\frac{2{,}958}{453} = 6{\cdot}5$	$\frac{2\,22^2}{2 \times 6{\cdot}5} = 0{\cdot}38$	$\sqrt{\frac{2 \times 6{\cdot}5}{0{\cdot}38}} = 6$
8	$7{\cdot}5 \times 80 \times 2{\cdot}22^2 = 2{,}958$	$\frac{1}{10}$	$\frac{2{,}958}{272} = 11{\cdot}0$	$\frac{2{\cdot}22^2}{2 \times 11} = 0{\cdot}22$	$\sqrt{\frac{2 \times 11}{0{\cdot}22}} = 10$
20	$7{\cdot}5 \times 80 \times 5{\cdot}55^2 = 18{,}480$	$\frac{1}{10}$	$\frac{18{,}480}{680} = 27{\cdot}0$	$\frac{5{\cdot}55^2}{2 \times 27} = 0{\cdot}57$	$\sqrt{\frac{2 \times 27}{0{\cdot}57}} = 9$
14	$\frac{7{,}500}{20} \times 3{\cdot}88^2 = 5{,}644$	$\frac{1}{6}$	$\frac{5{,}644}{1{,}133} = 5{\cdot}0$	$\frac{3{\cdot}88^2}{2 \times 5} = 1{\cdot}5$	$\sqrt{\frac{2 \times 5}{1{\cdot}5}} = 3$

On descending the 8 and 5 per cent. inclines, the cars are out of circuit, and the speed is regulated simply by the mechanical chain brake with perfect safety.

With regard to the accident already referred to, and which occurred at kilometre 6·1, about 800 metres (875 yards) from the summit, it transpired afterwards that the driver started with an overloaded car and at an excessive initial speed; and that having applied the hand brake, he tried, in addition, to reverse the motors, but instead of doing so, put the current on again, thereby suddenly accelerating the motion of the car which, on passing through a polycentric curve of 42, 20, and 14 metres radius, on an intermediate incline of 3 per cent., was thrown off the rails against a parapet. The car having covered the distance of 800 metres in a little over a minute, must have acquired a speed of 45 kilometres (30 miles) per hour, so that the centrifugal force in the 14 metres curve was:—

$$\frac{7{\cdot}5 \text{ tons}}{10} \times \frac{12{\cdot}5^2 \text{ metres per second}}{14} = 8{\cdot}32 \text{ tons,}$$

which, being in excess of the weight of the car (7·5 tons), accounts for its being thrown off at that point. This sharp curve, which has been widened since, probably averted a greater disaster, which might have happened had the car continued unimpeded in its downward course; at all events the rigidity and solidity of both the rolling stock and permanent way are attested by the fact that while the superstructure of the car was broken, the frame and motors sustained only trifling damage, and the permanent way was found in perfect condition.

COST OF CONSTRUCTION, EQUIPMENT AND WORKING.

The cost of the line was as follows:—

	Lire	£
Works, permanent way, sidings, buildings, stations, and accessories	325,000	13,000
Three boilers and three engines 80 H.P. each	100,000	4,000
Electric plant, three dynamos, twelve car-frames, with motors, wires, &c. ...	225,000	9,000
Twelve passenger cars	25,000	1,000
Telephone and sundries	25,000	1,000
Total	700,000	28,000

Equal to 96,000 lire per kilometre = £6,144 per mile.

The working expenditure, based on an average of 600 car kilometres, or 375 car miles per day, works out as follows:—

	Lire per day.	Centimes per car-kilometre.	Pence per car mile.
Traffic: eleven guards, 2·50 lire each, and three inspectors 3·50 lire each	38	6·3	0·96
Maintenance: one inspector, 8 lire, one foreman, 3 lire, and eight men 2 lire each	27	4·5	0·68
Motive power: one foreman engine room, 6 lire, one foreman boilers, 4 lire, two assistants, 2·50 lire each, and ten car drivers, 3·50 lire each, fuel one ton, 40 lire, oil, water supply, repairs, and sundries, 20 lire	110	18·3	2·80
	175	29·1	4·44
Depreciation and Renewals: boilers, 7%; electric plant, mean, 8%; cars, 5%; line, 1%; $\frac{29{,}500}{365}$	81	13·5	2·08
General charges: rates and taxes, 10,000 lire; easements, office, and administration, 5,000 lire; $\frac{15{,}000}{365}$	41	6·9	1·05
Total lire	297	49·5	7·58

It will be observed that the comparatively high charges for fuel and taxes are, as is usual in Italy, more than compensated by the lower scale of wages and the moderate cost of administration, the latter being, moreover, in the present case, only a *pro rata* share of the total mileage worked by the company.

If, instead of by electricity, the line were worked by eight ordinary 16-ton adhesion engines, or by the same number of 12-ton combined adhesion and rack engines, the total cost of construction and equipment would have been, as shown below, in the first case about £6,000 less, and in the second case slightly more than that of the electric railway.

	Adhesion. £	Adhesion and Rack. £
Works	13,000	13,000
Rack 2·7 kilometres	...	4,000
Eight engines	5,000	8,000
Twelve carriages	2,400	2,400
Sundries	1,000	1,000
	£21,400	£28,400

As regards the working expenditure, the cost per day of an engine of either description, running 100 kilometres, or 60 miles per day, is:—

	Lire.
Fuel, 600 kilogrammes, 40 lire per ton ...	24
Oil and repairs	6
Driver and stoker	9
Total lire	33 = £1·32

Hence for six engines running (two in reserve), the cost is 214 lire per day, $= \frac{214 \times 100}{600 \text{ kilometres}} = 35{\cdot}7$ centimes per train kilometre, or 5·46 pence per train mile, which is nearly double the cost of electric motive power, so that the latter represents a saving of 50 per cent.

Moreover, the total cost per car kilometre will be still further reduced whenever the line is extended to the centre of Florence, whereby the traffic will be considerably increased, and the motive power, notably on the level section, more fully utilised. The number of passengers carried at present is, on an average, 600 per day, and upwards of 2,500 on feast and holidays, the fares charged being at the rate of 10 centimes per kilometre, or 1½d. per mile.

CONCLUSION.

There can be no doubt that, for a steep grade line, such as the Florence and Fiesole Railway, with a 10 or 20 minutes passenger service, electric motive power offers advantages far superior to those of any other known system of traction.* On other lines with similar or steeper grades, such as the Utliberg near Zurich (7·5 per cent., 25-ton adhesion engines), the Barcelona (8 per cent., 17-ton adhesion engines), the Chianta of Florence (6 per cent., 20-ton adhesion engines), or the Drachenfels (Bonn), Stuttgart, Achensee (Tyrol), and Salzburg rack railways (20 per cent., 18-ton rack engines), where the train service is less frequent, the advantages of electric motive power would, of course, disappear, because, owing to the intermittent character of the demand, the current could not be adequately utilised. As regards economical working, notably of suburban lines, the nearest approach to electric motive power is probably Rowan's steam car, which is used on a line with 7 per cent. gradients at Stockholm. It contains a 6-ton motor working up to 14 atmospheres (200 lbs. per square inch), and carries from 30 to 50 passengers, the total weight available for adhesion being 11 tons, and develops a tractive force of 1,000 kilogrammes, equal, at 8 kilometres per hour, to 30 H.P. But this, too, necessitates turntables or triangular turnouts, and requires,

* The steepest incline the cars could ascend with the ordinary tractive effort of 1,013 kilogrammes (30 H.P. at 8 kilometres per hour) is $\frac{1{,}013}{7{\cdot}5}$. On the descent, where the momentum of the car at the same speed would be $7{\cdot}5 \times 125 \times 2{\cdot}22^2 = 4{,}622$ metre-kilogrammes, the mechanical chain brake applied with a pressure of only 30 kilogrammes, would, at $\frac{1}{6}$th adhesion, stop the car in 6 seconds within a space of 7 metres, and at $\frac{1}{10}$th adhesion, in 10 seconds within a space of 11 metres. Cars of 7 or 8 tons weight can, therefore, be worked with perfect safety on continuous inclines of 10 to 11 per cent. without the aid of a rack, the two safety brakes being, of course, always available in the event of the mechanical chain brake failing to act.

moreover, the very best coke to make it comparatively smokeless.* Considering the easy and elastic motion of the electric car described in this paper—its adaptability to sharp curves; the ease with which it can be run in either direction without being turned; the advantage of the current serving at once as motive power, brake and illuminant; the total absence of smoke and heat; and the fact of the whole car weight being available for adhesion—it may safely be averred that on the Florence and Fiesole railway the application of electricity by continuous current has been brought to a high degree of perfection.† The system may be rendered still more economical, if the power generated independently by the motors acting as dynamos can be made available as motive power conjointly with the current, to which object the attention of some leading electricians is now directed.

The drawings annexed to this paper, and the particulars given in it are all from measurements taken by the author on the spot; and for the purpose of comparison with other electric railways, he has compiled the following table from data for which he is indebted to the courtesy of the managers of the several undertakings.

Opened in	—	Length in kilometres.	Gauge in metres.	Maximum gradient per cent.	Minimum radius curve in metres.	Total H.P.	Cost of line in francs per kilometre.	Cost of line in pounds per mile.	Kilometres run per day.	Working expenses per train-kilometre in centimes.	Working expenses per train mile in pence.	System.
										Centimes.		
1881	Berlin and Lichterfelde ...	2·5	1·00	1·0	30	...	...	...	...	75 (2 cars)	11·49	Siemens and Halske
1888	Do. do. extension...	1·4	1·00	1·0	30	...	...	...	...			
1883-5	Mödling (Vienna)... ...	4·4	1·00	1·6	30	185	40,000	2,552	214	47·0	7·20	" "
1884	Frankfort and Offenbach...	6·7	1·00	3·0	30	230	147,000	9,378	1,400	58·0 (2 cars)	8·89	" "
1889	Vevey and Montreux ...	10·4	1·45	4·5	40	240	65,000	4,147	1,013	40·0	6·13	Vevey and Montreux Electric Works Company
1890	Buda-Pesth	9·1	1·45	1·6	25	500	...	...	1,085	...*	...	Siemens and Halske
1890	Florence and Fiesole ...	7·3	1·45	8·0	18	240	96,000	6,125	600	49·5	7·58	Sprague

* The Report of the first year's working has not been published as yet.

On the old Lichterfelde line the circuit is formed, as is well known simply by the rails. On the next four lines, both the conducting and contact wires were placed overhead, but laterally to the line, the current being transmitted to the cars by a small trolley running in a slot along the contact wire; whereas the Florence line has the simpler and, especially on steep grades, far more effectual arrangement of a central overhead contact wire and trolley pole. The Pesth lines are the only ones constructed on the underground channel-and-slot system which, on account of the cast iron tubular and equidistant supports under the rails, the concrete for filling up the intermediate spaces, and the more complicated arrangement of the permanent way, is of necessity very costly; so much so, that an extension of the Pesth lines in course of construction, is being made with overhead wires. Nor is there any doubt that this latter system, both on account of its greater simplicity and economy, is preferable wherever practicable. On the Mödling line, power is generated by a locomotive engine of 140 H.P. adapted for the purpose, in addition to three small stationary engines of 15 H.P. each; while the Montreux line utilises the local water power owned by the company, the dynamos being driven by two turbines of 120 H.P each. The mean cost of construction of these two lines and the Florence railway was only £4,200 per mile; their mean working expenditure is 45 centimes per train-kilometre or 7d. per train-mile, and in the present state of the science, the three lines may be regarded as typical examples of economical, efficient, and in every respect successful electric railways.

NEW PATENTS—1891.

15,075. "An improved portable electric lamp." R. THOMPSON and H. S. PYNE. Dated September 7th.

15,094. "Improvements in the manufacture of leaves for lamp, candle, or electric light shades." H. TROTMAN. Dated September 7th.

15,096. "Improvements in feed mechanism in relation to arc lamps." A. A. GOLDSTON. Dated September 7th.

15,123. "Improvements in or connected with systems of electric distribution wherein electrical storage batteries are used." H. EDMUNDS. Dated September 7th.

15,125. "Improvements in electrical storage cells and elements therefor." A. J. JARMAN. Dated September 7th.

15,162. "The improved medical electrode or electro-medical battery." M. A. HILLOCK and E. VENABLE. Dated September 8th.

15,206. "Improvements in phonographs." G. E. GOURAUD. (Communicated by T. A. Edison, United States.) Dated September 8th.

15,214. "Improved construction of telephone receiver." R. R. HARPER. Dated September 8th.

15,240. "An improvement in bobbins for dynamo-electric machines." SIEMENS BROTHERS AND CO., LIMITED, and F. HIRD. Dated September 8th.

15,262. "Improvements in coin-freed apparatus." J. M. M. MUNRO and MUNRO'S ELECTRICAL MANUFACTURING COMPANY, LIMITED. Dated September 9th.

15,276. "An electric apparatus for the purpose of starting races of all kinds." T. JOHNSON and J. GINDRAUX. Dated September 9th.

15,299. "Improvements in electrical signalling apparatus, chiefly designed for police service." W. R. LAKE. (Communicated by the New Haven Clock Company, United States.) Dated September 9th. (*Complete.*)

15,321. "An improved electrical regulator or governor." E. A. CLAREMONT. Dated September 10th.

15,337. "An improvement in standard electrical condensers." A MUIRHEAD. Dated September 10th. (*Complete.*)

15,363. "Improvements in alternating current motors." H. C. E. JACOBY. Dated September 10th.

15,377. "An improved electric globe gallery and shade holder." J. WHITEHEAD. Dated September 11th.

15,407. "Improvements in galvanic batteries." G. COHEN. Dated September 11th.

15,432. "Improvements in electrical igniting apparatus." T. PARKER and W. ARMISTEAD. Dated September 11th.

15,440. "Improved apparatus for periodically passing currents of electricity through a conductor." R. H. TWIGG. Dated September 11th.

15,474. "Improvements in hydro-carbon motors." C. T. WORDSWORTH. Dated September 12th.

15,480. "Improvements in or relating to dynamo-electric machines." W. P. THOMPSON. (Communicated by L. Dahlmann and F. Kirster, Germany.) Dated September 12th.

15,483. "Improvements in electric lighting and in the means therefor." J. C. MEWBURN. (Communicated by P Sée, France.) Dated September 12th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

6,083. "Improvements in effecting the electric propulsion of tramcars and apparatus therefor." J. GORDON. Dated April 22nd. 1s. 1d. Relates to a modification of what is now generally known amongst electrical engineers as the "sectional rail system;" the improvements affording increased economy in the cost of installation, greater efficiency and certainty in working, and ensuring safety to the ordinary road traffic. 6 claims.

6,726. "An electrical timepiece combined with installations for the distribution of electrical energy for lighting and other purposes." F. VON HEFNER-ALTENECK. Dated May 1st. 8d. Relates to a construction of electrical timepieces wherein the regulating action is effected by means of an electrical current derived from the same installation that supplies electrical energy to lamps or other apparatus, the potential of the current supplying the lamps being for this purpose momentarily decreased or increased at regular intervals of time, whereby the pointers of all the timepieces connected to the distributing network are adjusted to the correct time. 5 claims.

6,801. "Improvements in apparatus for testing leakage and insulation of electrical conductors." A. B. HOLMES. Dated May 2nd. 6d. Consists broadly of a voltmeter, an ammeter and an automatic cut-out combined with a variable resistance fixed in the circuit of the ammeter, also a registering device by which the indications of the voltmeter and ammeter, or of either of them, are automatically, continuously or intermittently registered by clockwork or other means. 1 claim.

* The first cost of such a steam car is about £800 at the works. It may be mentioned that in some countries, *e.g.*, in Italy, the authorities only allow a pressure up to 12 atmospheres (165 lbs. per square inch). Rowan's steam car is also used on seven other light railways in Sweden, and on suburban lines at Copenhagen, Berlin, Saarbrücken, Moscow, Paris, Tours, Lyons and Marseilles. All these lines are, however, more or less level.

† On an ordinary horse tramway of three miles on the Via Flaminia in Rome, a few cars have, for some time, been run on the "series" system, similar to that of the short Northfleet line, but with four overhead, instead of underground wires. The installation and working are, however, too experimental to admit of an adequate opinion being formed as to the merits claimed for the system.

7,932. "Improvements in mandrils for electrolytically deposited tubes." F. E. ELMORE. Dated May 22nd. 6d. Relates to the construction of mandrils for electrolytically depositing metal, the object being to make them light, strong, evenly balanced and smooth, and to give facility for removing them from the shells of metal deposited on them. 4 claims.

8,651. "Improvements in casing for electrical conductors, cables, or the like." T. SMITH. Dated June 4th. 6d. The inventor forms grooves of iron or other suitable metal by means of rolling or other similar methods, and he makes as many grooves as may be necessary, and with such thickness of metal between them as may be thought advisable. The metal may be formed of such thickness as to give it a certain amount of spring, so that the cables can be slipped into their places, and held there by the spring of the metal. The covers may be made to spring or slide on or off, and may be attached to the lower part by screws or the like; they may be ornamented or embellished in any way desirable. After the grooves and cover are shaped into their necessary form, he covers them with insulating substances in the following way:—He heats them to a suitable point, and then immerses them into a bath of asphaltum or other hydrocarbon possessing a suitable degree of elasticity when cold; he then withdraws the metal and allows the covering to set, or he may paint the metal with the insulating substance and afterwards raise the metal to a suitable temperature, whereby the substance may enter into closer connection with the metal. 4 claims.

9,163. "An improved automatic electrical switch or cut-out for use in connection with dynamos and accumulators to be charged thereby." F. M. NEWTON and T. HAWKINS. Dated June 13th. 8d. Comprises a shunt coil of high resistance arranged between the poles of the dynamo, and a series coil adapted to have its circuit closed only when the E.M.F. of the dynamo reaches a certain limit. The coils are each wound on an iron core, attached to or formed in one with an outer case enclosing the coils, the whole forming an electro-magnet. When the E.M.F. of the dynamo exceeds that of the accumulator, the magnetic attraction between the iron case containing the shunt coils and the iron case containing the series coils overcomes the action of gravity or the force of the spring, and causes the shunt electro-magnet, which is made movable on a spindle, to move towards the iron case containing the series coils, which is fixed, thereby closing the main circuit by a suitable mechanical device. The main current then passes through the series coils, which, acting in the same sense as the shunt coils, causes the two iron cases to be more firmly attracted, and ensuring a firm contact. As long as the main circuit is closed, and the E.M.F. of the dynamo exceeds that of the accumulator, the main and shunt coils act in the same sense; but should the E.M.F. of the dynamo fall below that of the accumulator, the current in the main series coils is reversed, and the two coils now acting in an opposite sense, the attraction between the iron cases ceases, and the force of gravity or, in some cases, a spring causes the movable iron case to fall or recede from the fixed one, and break the main circuit. Should this force, however, be insufficient to overcome the friction of the switch or other parts of the apparatus, a slight increase in the current flowing back from the accumulator through the series coils causes sufficient magnetic repulsion between its iron case and that of the shunt coil magnet to ensure the opening of the switch. 2 claims.

9,257. "Process for effecting electrolytic deposit with aluminium." S. WOHLE. Dated June 14th. 4d. Claim:—The described process for effecting electrolytic deposit with aluminium on suitable cathodes by preparing as described from alum, pearl-ash and potassium cyanide the liquid charge for the electrolytic bath, providing the bath with perforated or slotted aluminium plates as anodes, and subjecting this bath to electrical action.

9,361. "Improvements in electric reduction of metals and in apparatus therefor." T. L. WILLSON. Dated June 17th. 11d. Relates to the introduction of a deoxidising or otherwise reducing agent in gaseous form, and in such manner that it shall be interposed between the liberated oxygen or other agent requiring elimination and the surfaces of the crucible and electrodes, which would otherwise be exposed to the destructive action of the oxygen, so that the oxygen is caused to unite with the gaseous agent thus introduced before it can gain access to the surfaces of the electrodes and crucible, so that the latter are protected from oxidation, and their wasting away is almost entirely prevented. 7 claims.

10,038. "Improvements in the electrolytic treatment of metals." A. WATT. Dated June 28th. 4d. The object of this invention is to prevent the metal under treatment in the electrolytic baths from depositing upon the edges and corners of the plates, and cause it to deposit only upon the plane or flat surfaces, which the inventor has found can be most effectually accomplished by protecting the edges and corners of the plates or cathodes by means of a frame constructed of some suitable non-metallic substance, such as wood, ebonite, or any suitable material not being a conductor of electricity. 1 claim.

10,276. "Improvements in electric search lights and in mechanism for feeding the carbons." H. J. ALLISON. (Communicated from abroad by B. B. Ward, of New York.) Dated July 3rd. 8d. Relates to the manner of mounting the electric arc light used for a search or focussing lamp, so that the lamp may be turned in either a horizontal or a vertical plane to throw the beam of light in any desired direction. The invention relates further to the construction of the regulating mechanism for feeding the carbon pencil of the arc light. 5 claims.

16,607. "Improvements in or connected with electric switches." C. R. BONNE. (Communicated from W. P. Daniels, of Germany,) Dated October 18th. 8d. The object of the invention is an electric switch that switches suddenly off and on. 1 claim.

19,272A. "Improvements in electric soldering irons." C. E. CARPENTER. Dated June 21st. (Under International Convention.) 8d. The prime object of this invention is to have the iron electrically heated, and of such construction that the wearing parts thereof may be readily replaced by new parts. 5 claims.

21,143. "Improvements in electric batteries for lighting miners' safety lamps." O. Y. RHODES. Dated December 29th. 6d. The lid of the improved battery is hermetically sealed, so that no spark can be formed without the lamp being placed upon the lid. Underneath the lid is an arrangement of well-known electric devices for making and breaking contact. The lid is also provided with a sliding plate, on the under side of which is an insulated stud, and above the plate is a short pillar, also carrying an insulated stud, or, as a matter of safety, the pillar itself may be composed entirely of insulated material surrounding the metal which makes contact with the stud. On the top of the sliding plate there is also fixed a concave projection, and the lamp to be lighted is placed upon the sliding plate with the bottom flange of the said lamp in contact with the concave projection; at the same time a horizontal stud, projecting beyond the surface of the lamp, is brought into contact with the insulated stud on the top of the pillar just mentioned, after which the operator forces the sliding plate forward, carrying the lamp with it, bringing the insulated projection on the underside of the plate against one of the poles of the battery, whereupon an electric current is established, and the wick in the lamp ignited. A spring draws the sliding plate back, removing the insulated stud from the pole of the battery, whereupon the electric current is cut off before the lamp is removed from the battery. 1 claim.

CORRESPONDENCE.

Train Lighting.

Referring to your leading article of the 18th inst. on the above subject, all interested in this important matter cannot but feel grateful to Mr. Timmis for bringing it before the British Association. At the same time, it is to be regretted that he did not take the trouble before writing his paper to ascertain what had actually been done in this direction on the English railways, and the result of the experience gained by those who have devoted so much time and attention for years past to the practical solution of the problem.

Had he done this he would soon have found that:—1. The system of placing smaller candle-power lamps and auxiliary batteries in the carriages for use during stoppages or shunting, if at all practicable, is quite inadmissible, as the British public would not put up with anything like the reduction in the light which he proposes. 2. Lighting the trains entirely by accumulators charged at a central station, although very pretty and feasible on paper is quite impracticable for many reasons well known to railway electrical engineers, irrespective of the expenses, which would be enormous. 3. The objection to a dynamo driven from an axle of the brake van (which, by-the-bye, is the only system which has made any headway in this country) exists only in his, Mr. Timmis's, imagination, as this system has been working for several years, very satisfactorily, in a considerable number of trains, both on the Brighton and Great Northern railways; and, lately, the Midland have adopted a similar system. In the latter case, as coaches have to be detatched on the journey, it has been, of course, necessary to place a small set of accumulators in each coach, which are without difficulty kept charged by the axle driven dynamo.

It is, also, as stated in your article, quite unnecessary for all the vans to be fitted with dynamos, as only one is necessary for each train.

I may also mention that the efficiency of the lamps, described in Mr. Timmis's paper, appears somewhat phenominal, viz., about 1·9 watts per candle power.

F. W. Cooke, A.I.E.E.

September 21st, 1891.

A New Method of Magnetic Suspension.

In your last issue I noticed a description of a new form of magnetic suspension by Mr. A. H. Allen. It may interest you to know that a friend of mine, Mr. Ralph Richards, invented an instrument on the same principle as that by Mr. Allen some 12 or 18 months ago. I do not know if it is yet perfected. I saw the preliminary experiments, and as it then stood the idea was more complete than that of Mr. A. H. Allen's.

T. W. Beyington.